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U. S. Department of Agriculture, Forest Service

FOREST PRODUCTS LABORATORY

In cooperation with the University of Wisconsin

MADISON, WISCONSIN

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THE EFFECT OF POLYPORUS SCHWEINITZII AND TRAMETES PINI ON THE SHOCK-RESISTANCE, COMPRESSION PARALLEL TO GRAIN STRENGTH, AND SPECIFIC GRAVITY OF SITKA SPRUCE

By

Reginald H. Colley, Pathologist,
and
T. R. C. Wilson and R. F. Luxford,
Engineers in Forest Products

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U. S. F. S. AUG 16 1941

Project L-249-JL

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THE EFFECT OF *POLYPORUS SCHWEINITZII* AND *TRAMETES PINI* ON THE SHOCK-RESISTANCE, COMPRESSION PARALLEL TO GRAIN STRENGTH, AND SPECIFIC GRAVITY OF SITKA SPRUCE.

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THE EFFECT OF POLYPORUS SCHWEINITZII AND TRAMETES PINI ON THE SHOCK-RESISTANCE, COMPRESSION PARALLEL TO GRAIN STRENGTH, AND SPECIFIC GRAVITY OF SITKA SPRUCE.

Purpose

The purpose of this study was to determine the effect of the action of two fungi, Polyporus Schweinitzii and Trametes pini, on the shock-resistance, compression parallel to grain strength, and specific gravity of Sitka spruce.

Description of Material

The material for the study consisted of Sitka spruce logs from two trees cut in the virgin forest in Lincoln County, Oregon (Laboratory shipment No. 987). One of the trees (tree 9) had been attacked in the butt (butt-rotted) by Polyporus Schweinitzii; and the other (tree 3) had been infected in the trunk, about 75 feet from the ground, by the red heart, or ring scale fungus, Trametes pini. Details of the size of the trees and the parts used in the investigation are shown in Figs. 18, A and 32, A.

Selection and Preparation of Test Specimens

Cutting up the Logs

Because of the importance of position in the tree as a factor in comparing sound and infected material,

as brought out in the later discussion, the methods of converting the logs into test specimens and of marking these specimens are described in considerable detail.

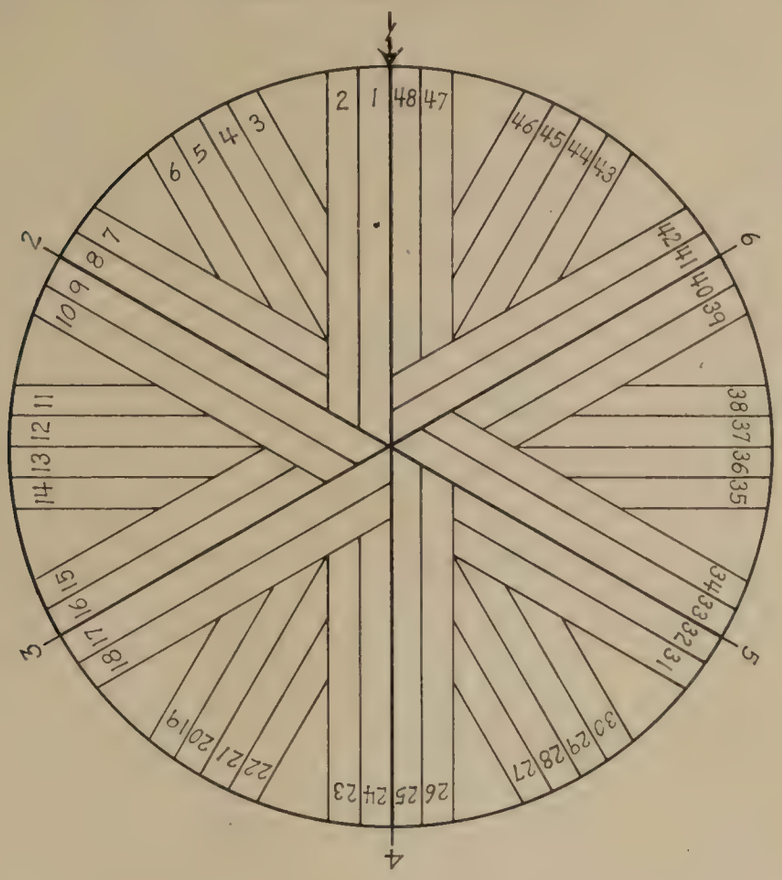
The material from tree 9 consisted of one log approximately 13-1/2 feet long. There were two logs from tree 3, one 19 feet long, and one 3 feet long. To orient the logs in the cutting up process a "guide line" was marked the full length of each log, so drawn as to be continuous if the parts were placed together in their original position.

The log from tree 9 was cut into two bolts approximately 6 feet 9 inches long. The lower bolt was marked 9A and the upper bolt 9B. Bolt 9B was later found uninfected and was used as a source of control specimens, as noted hereinafter. The upper 20 inches of bolt B was discarded.

The 19-foot log of tree 3 was cut into 3 bolts, each approximately 6 feet 3 inches long, marked bolts 3A, 3B, and 3C, beginning at the lowest. The short 3-foot log from tree 3 was labelled bolt 3D. The upper 18 inches of bolt D was not used.

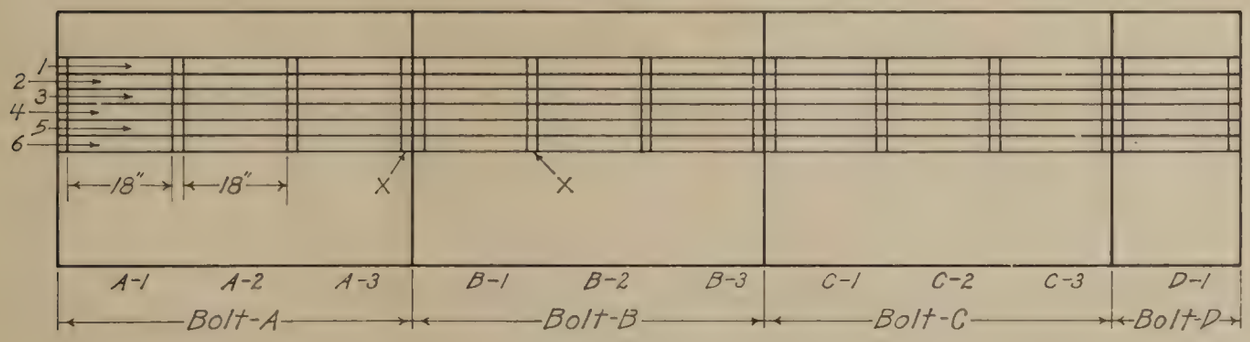
The upper end of each bolt was then marked as follows: The point where the guide line met the circumference of the cross section (see the arrow in Fig. 1,A)

DIAGRAM SHOWING HOW TREES 3 AND 9 WERE CUT INTO BOARDS AND SPECIMENS

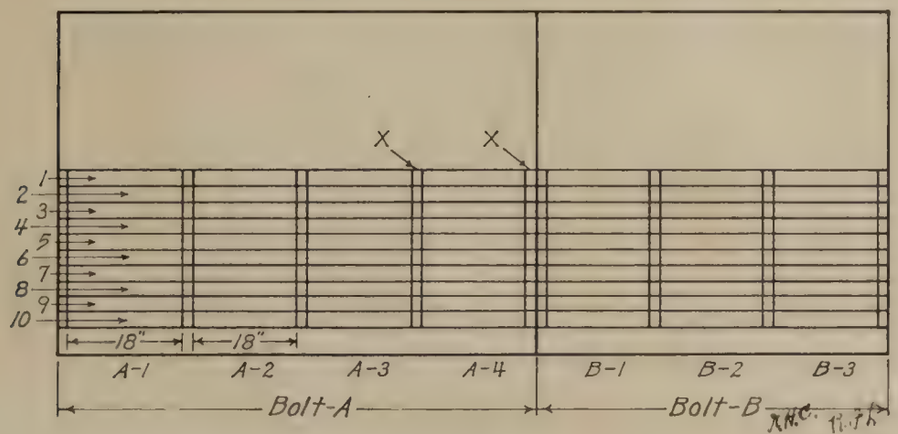


-A-

SAMPLE BOARD - TREE - 3 -B-



SAMPLE BOARD - TREE - 9 -C-



SHIPMENT 987
PROJ. 243-J1

Figure -1

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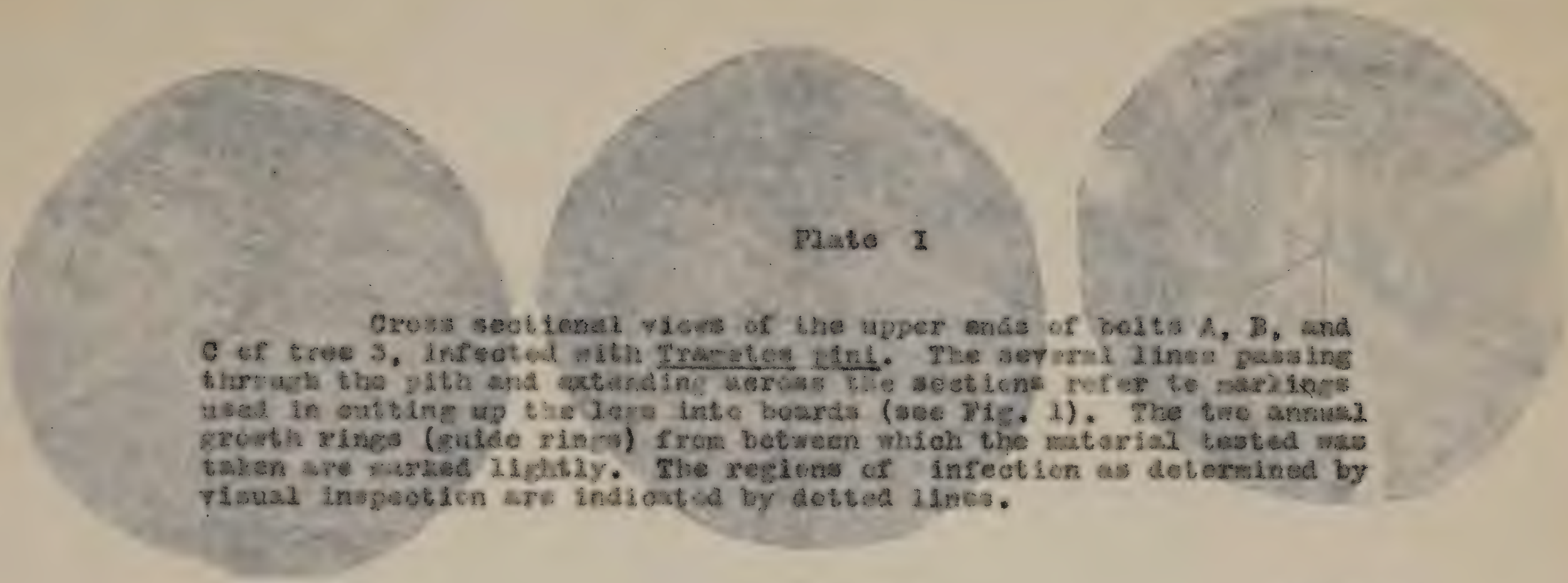
was labelled 1. From this point a straight line was drawn through the pith to a point on the opposite circumference. The latter point was labelled 4. Two other diameter lines, labelled 2-5 and 3-6, were drawn at 60° to the 1-4 line. The general plan of the layout of these three principal diameter lines is shown in the photographs of the upper ends of bolts A, B, and C of tree 3, in Plate II.

Notes were taken of the dimensions of the cross sections along the three principal diameters, of the presence of scars, callus tissue, etc., and of the extent of infection as determined by visual inspection. Counts were made of the annual rings to establish the approximate age of the wounds under the scar tissue.

The bolts were then quarter-sawed into boards 1-1/8 inches thick and numbered after the manner indicated in Fig. 1, A.

Laying out the Cutting Plan for the Test Specimens

Boards numbered 1, 2, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 41, 42, 44, and 48, were chosen for test from tree 9; and boards 2, 4, 6, 8, 10, 12, 14, 16, 18, 22, 26, 30, 34, 38, 42, 44, 46, and 48 were chosen from tree 3. The positions of these boards are shown in Fig. 1, A.



Bolt A Bolt B Bolt C

PLATE I

Plate I

Cross sectional views of the upper ends of bolts A, B, and C of tree 3, infected with Trametes pini. The several lines passing through the pith and extending across the sections refer to markings used in cutting up the logs into boards (see Fig. 1). The two annual growth rings (guide rings) from between which the material tested was taken are marked lightly. The regions of infection as determined by visual inspection are indicated by dotted lines.

Serial Path.-1



Bolt A



Bolt B



Bolt C

PLATE I

The same general scheme was followed in laying out the cutting plan for the test specimens in trees 3 and 9, but the specimens were taken from different regions in the two sets of boards on account of the way the two fungi attacked the trees.

In tree 3 Trametes pini had spread from a wound received about 66 years before the tree was felled, and the infected wood was located in the outer portion of the bole (see Plate I). In this tree the 66th annual ring in from the cambium was used as a base ring, or guide ring.

The first step in the laying out of specimens from both trees consisted in placing all boards bearing the same number end to end and matching them ring for ring. For example, the four boards bearing the number 2 from bolts 3-A, 3-B, 3-C, and 3-D, when arranged and matched in this manner, represented a single board No.2 20 feet long out from the original 22 feet of log. The base ring was marked out in each case, and in each bolt a straight line was drawn on the board to coincide as nearly as possible with this base ring. From this straight line the individual specimens were laid out toward the center of the tree. The layout for representative boards from both trees is shown schematically in Fig. 1, B and C. In tree 3 six specimens were cut from each of three positions in each board of bolts

A, B, and C, and from one position in each board of bolt D. There were, therefore, 10 sets of specimens, bearing the sub-bolt designations A-1, A-2, A-3, B-1, B-2, B-3, C-1, C-2, C-3, and D-1 from each board in this tree.

The part of tree 9 used for test and examination represented the central portion of the bole, beginning at a point nine feet from the ground (see Fig. 18, A). The fungus, Polyporus Schweinitzii, had apparently entered through a fire scar at the base of the tree. At the lower end of bolt A the scar was approximately 162 years from the cambium. The specimens were therefore taken from the parts of the boards inside the 162nd annual ring, counting from the cambium.

A maximum number of 10 specimens were taken from each of four positions in the boards of bolt A and from each of three positions in those of bolt B. The exact number depended on the width of the boards. The seven sets were designated A-1, A-2, A-3, A-4, B-1, B-2, and B-3. The specimens from both trees measured approximately 1-1/8 by 1-1/8 by 18 inches in rough form.

The horizontal lines bearing the designations A-1, A-2, etc., shown on the trunks marked "A" in Figs. 18, 19, and 32, represent cross-sectional planes passing through the central portion of all the specimens

in the A-1, A-2, etc. positions. Each cross-section diagram (Figs. 2 to 17 and 20 to 31, inclusive) represents the properties of a sub-bolt extending approximately 10 inches in tree 9, and 12 inches in tree 3 on each side of the cross-sectional planes shown.

Conditioning the Specimens

During the laying out and cutting process considerable drying took place, and it is estimated that the specimens in rough form had a moisture content of approximately 30 per cent. Immediately after being moved from the boards the specimens were stacked in open piles in a conditioning room, which was maintained at a relative humidity of 60 per cent, until the moisture content came as nearly to equilibrium as practicable. They were then recut to a uniform size of 3/4 by 3/4 by 17 inches. The moisture content of the specimens at time of test was found to range between 12-1/2 and 14 per cent, based on the oven-dry weight.

Method of Tests

The following tests were made:

Toughness--third-point loading
Compression parallel to grain
Specific gravity

Toughness

The toughness test pieces were 3/4 by 3/4-inch in cross section and 17 inches long. The span was 13-1/2 inches and the load was applied at the third-points. A special third-point loading apparatus was used for applying the load. Plate II shows the toughness test machine with this third-point loading apparatus in place.

All odd-numbered specimens were tested with the load applied on the tangential or flat-sawn face and the even-numbered specimens with the load applied on the radial or edge-grain face.

Compression Parallel to Grain

The compression parallel to grain specimens were 3/4 by 3/4-inch in cross section and 3-1/2 inches long. They were tested in the usual manner[1] and for maximum load only.

Specific Gravity

The specific gravity of each specimen was determined from its dimensions, weight, and moisture content when tested[2].

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[1] See Forest Service Circular 38, "Instructions to Engineers of Timber Tests", page 22.

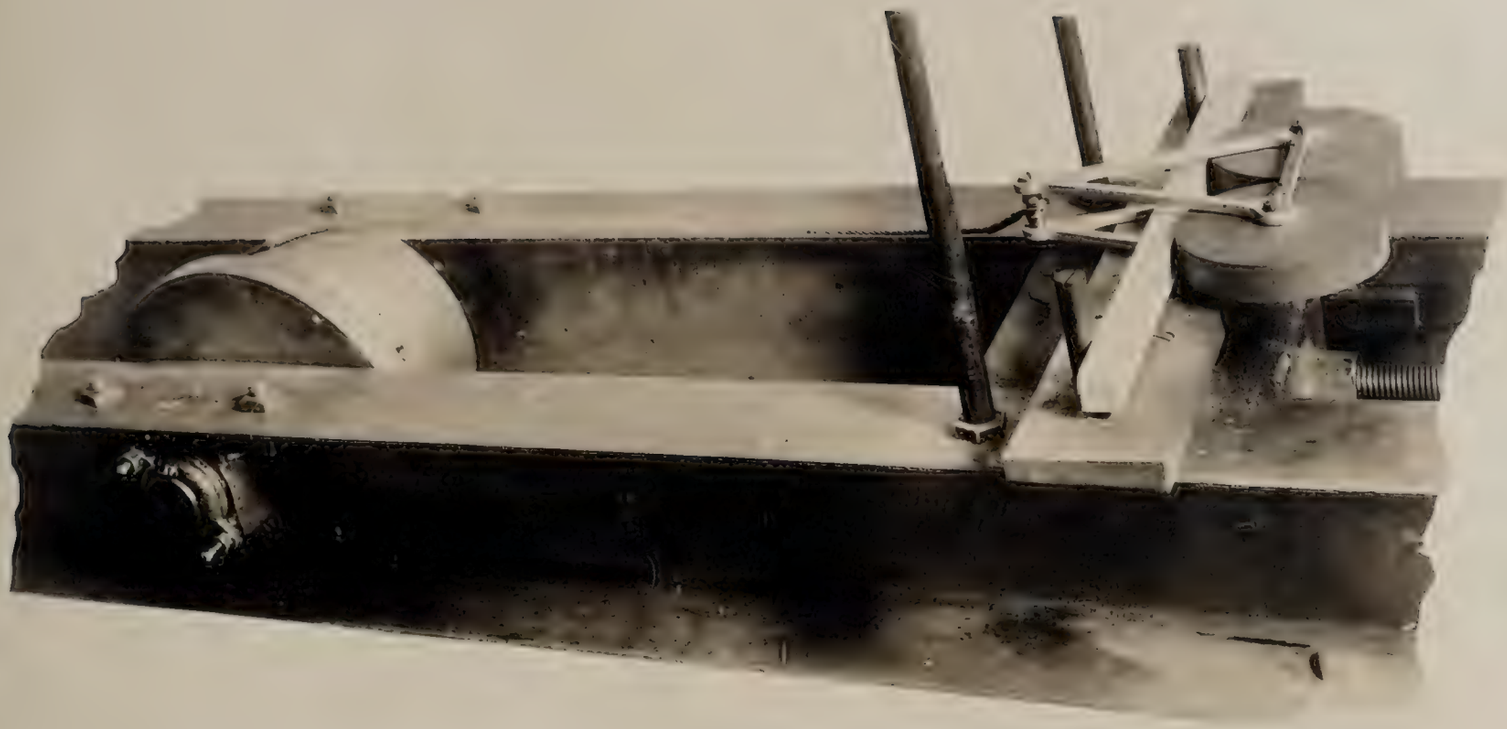
[2] See formula on p. 35, U.S. Dept. Agr. Bul. 356, "Mechanical Properties of Wood Grown in the United States."

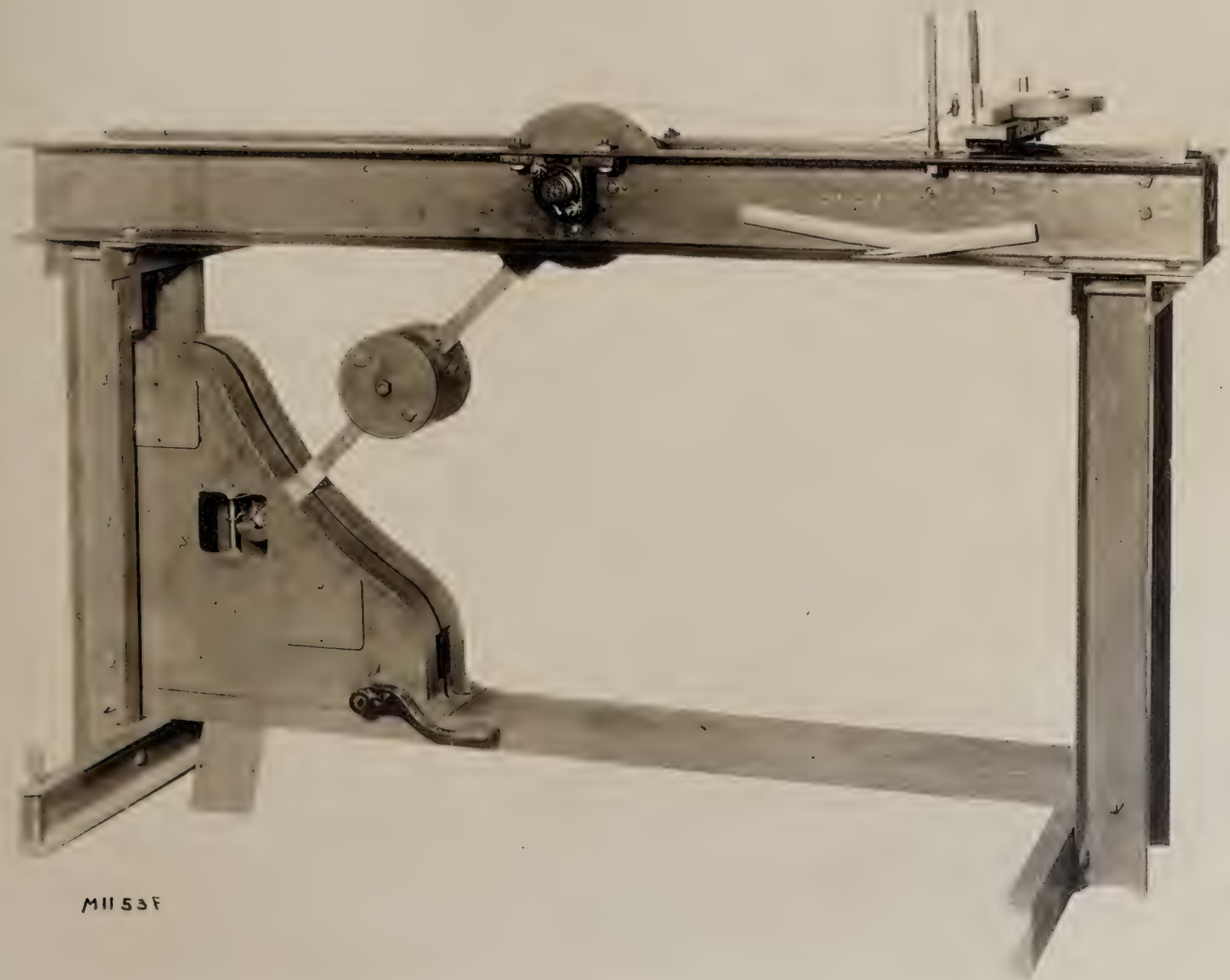


Plate II

Toughness testing machine fitted
with third-point loading apparatus.







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Determining the Limits of Infection

One or more of three methods were used to determine infection in the belts, boards, and specimens: visual inspection, culture tests, and microscopical examination.

It is difficult to describe the changes which take place in the appearance of Sitka spruce infected with either of these two fungi so that one unfamiliar with the phenomena would be able to recognize the early stages of infection. The early stages of decay produced by Polyporus Schweinitzii, are more easily overlooked than the early stages of "red heart" (Trametes pini). The two fungi attack the wood in very different ways. Trametes pini, in the early stages of decay, changes the color to a light or dark brown, and later destroys the wood entirely in more or less isolated spots, producing little pockets lined with white cellulose fibers (see 3, Pl. II). The wood between the pockets often remains quite firm. The outer edge of the infected part frequently becomes heavily infiltrated with resin. Polyporus Schweinitzii infection "first becomes evident in Sitka spruce as pale yellow to lemon yellow streaks or spires extending longitudinally beyond the light yellowish to reddish brown discoloration which characterizes the more

Introduction to the Study of Literature

One of the most difficult questions to be answered [illegible] is this: Because, such questions [illegible] cannot [illegible] investigation, and there [illegible] must be answered: and answered [illegible].

It is difficult to determine the exact point [illegible] where [illegible] the dynamics of [illegible] [illegible] with either of these [illegible] to what one [illegible] the phenomena would be held to [illegible] the early [illegible] of literature. The study [illegible] [illegible] by [illegible] [illegible], the more will [illegible] the early [illegible] of "real" [illegible]. The [illegible] [illegible] [illegible]

visible incipient decay" (See 3, p. 35)[3]. Later, the infected wood turns uniformly brown, and until it becomes soft and weakened to such an extent that there is no strength left, the only visible evidence of infection is this brown color.

Visual Inspection

The apparent limits of infection with Trametes pini in tree 3 were traced on the upper ends of bolts A, B, and C, as shown in Plate I. On the other hand, it was impossible to estimate by visual inspection the limits of infection with Polyporus Schweinitzii in tree 9. Also, after the boards had been planed it was comparatively easy to outline the apparent boundaries of the Trametes pini infection (tree 3), but out of the question to do so in the case of Polyporus Schweinitzii (tree 9).

Culture Tests

Culture tests were made on the blocks marked X in Fig. 1, B and C, and on certain test specimens after the mechanical tests had been completed. The blocks were split and small slivers of wood were then cut from the newly exposed surfaces and placed in test tubes containing malt-extract agar. The results were recorded as positive or negative, depending on whether the fungus did or did not grow from the slivers.

---

[3] See Boyce, J.S., "Decays and Discolorations in Airplane Woods." U.S. Dept. of Agric. Bul. 1128, Feb. 20, 1923.

Microscopical Examination

Sections were cut from all specimens located at or near the estimated limits of infection in each tree. These sections were stained, mounted, and then examined microscopically for evidence of infection.

Mapping the Infected Areas

In Tables 1 and 2, and in the diagrams representing the cross sections, infection is indicated by a black dot. All the evidences of the presence of the fungi, visual, cultural, and microscopical, were used in determining the limits of infection as indicated in Figs. 2 to 17 and 20 to 25, inclusive. For tree 3 the limits of infection so defined do not exactly agree with the somewhat smaller limits determined by visual inspection alone, as shown in Plate I. The limits are believed to be correctly marked in Figs. 2 to 17 and 20 to 25, but there are certain chances of error at the extreme limits which should be mentioned. Briefly stated, they are these: It is always possible to miss finding the evidence of infection by both the culture test and the microscopical examination; for the particular sliver chosen for culture may not contain live fungous threads, and the thin section mounted for examination may not contain any threads at all, alive or dead.

Table I

Tabular diagrammatic presentation of toughness and compression parallel to grain test results; tree 9, Sitka spruce, infected with Polyporus Schweinitzii. The data in this table have been arranged in diagrammatic form to show the relative position of each specimen within a board. Each infected specimen is indicated by a black dot, to bring out plainly the region of infection within a board. The relative cross-sectional position of each board is shown in figure 1, A.

...p rallel-to-grain test results.

Tree species
Sitka spruce

Fungus species
Polyporus schweinitzii

Board No.	Specimen No.	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]
		Bolt A-1					A-2					A-3					A-4					B-1					B-					B-3				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
1	1	.429	400	S_1T	5960		.431	718	S_1T			.450	651	S_1T	6430		.442	574	S_1T			.455	377	S_1T	5960		.457	582	S_1T			.461	692	S_1T	6330	
	2	.490	402	SS_1T	7240		.458	543	S_1T			.470	326	S_1T	7070		.49[illegible]	364	S_1T			.477	400	S_1T	6140		.461	303	S_1T			.441	326	S_1T	6820	
	3	.482	224	S_1T		•	.452	678	S_1T	6810	•	.484	627	S_1T			.490	253	S_1T	7150		.461	497	S_1T			.459	426	S_1T	6110		.447	476	S_1T		
	4	.455	78	B		•	.492	151	SmT	[illegible]	•	.47[illegible]	114	S_1T		•	.466	446	S_1T	[illegible]		.467	490	S_1T			.491	365	Xg	7460		.484	467	S_1T		
	5	.399	96	F	5950	•	.399	124	B		•	.455	128	S_1T	7[illegible]	•	.447	[illegible]	S_1T			.440	476	S_1T			.459	349	S_1T			453	499	S_1T	6665	
	6		44	F	4470	•	377	92	F		•	477	231	S_1T	[illegible]	•	.487	337	S_1T			[illegible]	528	S_1T	7740		.497	339	S_1T			.483	576	S_1T	7480	
	7	.389	13	B		•	.393	85	F		•	.404	181	S_1T		•	.421	408	S_1T			.413	404	S_1T			.422	200	B	3015		.422	466	S_1T		
	8																					.424	366	S_1T			407	265	S_1T	6005		.321	356	S_1T		
	9																					.433	383	S_1T			.405	400	S_1T			.387	343	S_1T		
2	1	.496	310	Xg	6390		.454	564	S_1T			.468	158	S_1T	[illegible]		.453	453	S_1T			.472	689	S_1T	6750		.465	578	S_1T			.467	510	S_1T		
	2	.499	200		6730		.486	361	S_1T			.474	466	S_1T	[illegible]		.471	313	S_1T			.467	396	S_1T	6860		.469	337	S_1T			.482	414	S_1T		
	3	.479	---	K			.464	780	S_1T	4670		457	501	S_1T			.459	547	S_1T	[illegible]		480	578	S_1T			.460	311	S_1T	6340		.456	588	S_1T	7135	
	4	.472	---				.472	123	SS_1T	6670	•	.[illegible]90	107	SR		•	.493	558	S_1T	7[illegible]		.483	163	S_1T			498	418	S_1T	7420		.480	413	S_1T	7160	
	5	----	---				----	---				----	---				----	---				488	637	S_1T	5845		.467	436	S_1T			.471	700	S_1T		
	6	----	---				----	---				----	---				----	---				497	552	S_1T	7635		488	386	S_1T			.500	702	S_1T		
	7	.402	40	B		•	.400	109	B	4990	•	.418	408	B		•	.420	420	S_1T	5985		.382	596	S_1T			.411	375	S_1T	6285		.432	524	S_1T		
	8	----	---				.418	[illegible]	F	[illegible]	•	[illegible]	219	S_1T		•	424	421	S_1T	[illegible]		.429	[illegible]	S_1T			.429	428	S_1T	[illegible]		.405	353	S_1T	[illegible]	
	9	.371	31	B	4340	•	.426	100	SB		•	.437	362	S_1T	6[illegible]75	•	.444	357	S_1T			.395	104	S_1T			.411	413	S_1T			.428	439	S_1T		
	1	.397	15	B	4960	•	.37[illegible]	[illegible]	B		•	.392	288	SS_1T	5995	•	.404	[illegible]3	SB																	
	10a	352	13	B		•	.367	80	B	4545	•	.399	89	B		•	[illegible]	82	B	[illegible]	•															
	10b	.368	87	B		•	.391	26	B	4060	•	.411	33	B		•	----	---																		
4	1	.425	104	B	5960	•	.444	188	S_1T		•	.397	296	SmT	6220		.395	229	S_1T			.401	298	S_1T	4545		.412	463	S_1T			.403	195	B	4980	
	2	.438	119	B	6720	•	.475	360	S_1T		•	.476	341	S_1T	6300		.45[illegible]	340	S_1T			.460	381	S_1T	6025		.475	406	S_1T			.482	349	S_1T	6770	
	3	.400	88	B		•	.492	254	S_1T	5745	•	.495	[illegible]	S_1T			497	[illegible]	S_1T	6940		.494	[illegible]	S_1T			.484	677	S_1T	[illegible]		.486	[illegible]	S_1T		
	4	.414	33	B		•	.429	112	B	6140	•	.445	179	S_1T		•	.441	[illegible]	S_1T	[illegible]		.441	401	S_1T			.[illegible]	495	S_1T	6880		.465	4[illegible]	S_1T		
	5	.431	36	B	5400	•	457	106	B		•	.453	[illegible]	S_1T	[illegible]	•	[illegible]	[illegible]	S_1T			----	---				---	---				---	---			
	6	----	---				---	---				----	---				---																		

See footnotes page 4.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
8	1	.638	54	B	4570	•	.496	90	B		•	.536	288	B	5290	•	.544	357	B			----	---				.529	402	P			.556	919	P	5660	
	2	----	---				----	---				.476	401	SpT	5810		.479	379	SpT			.471	379	SpT	6520		.480	329	SXg			.462	333	SP	5825	
	3	----	---				.446	187	SB	5990	•	.457	450	SpT			.474	481	SpT	6855		.444	731	SpT			----	511	SpT	6395		.452	439	SpT			
	4	.455	24	B		•	.467	88	SB	6940	•	.494	552	SpT		•	.485	484	SpT	7390		.457	514	SpT			.460	423	SpT	6815		.467	413	SpT			
	5	.402	20	B	4275	•	.415	104	B		•	.437	525	SpT	6405		.440	426	SpT			.416	541	SpT	6170		.412	720	SpT			.421	465	SpT	6220	
	6	.435	22	B	4080	•	.484	36	B		•	.479	330	SpT	7100		.470	402	SpT			.444	497	SpT	6330		.447	561	SpT			.451	392	SpT	6070	
	7	.404	18	B		•	.425	124	B	5840	•	.419	413	SpT		•	.415	399	SXg	5750		.403	416	SpT			.410	552	SpT	6040		.410	442	SpT			
12	1	.636	238	B	5490	•	.520	283	B		•	.654	300	B		•	.616	554	B		•	.646	156	SB	4200	•	.583	126	K		•	----	---				
	2	.459	116	B	4545	•	.458	156	SB		•	.497	173	SB	5180	•	.518	264	B		•	.586	116	B	4075	•	----	191	SpT		•	.436	256	SB	5040	•
	3	.472	145	B		•	.474	385	SpT	7120	•	.487	472	SpT		•	.480	717	SpT	7200	•	---	---				.396	219	SB	4330	•	.435	244	SmT		•
	4	.437	109	B		•	.435	225	SpT	5270	•	.458	329	B		•	----	---				.435	281	SpT		•	.431	203	SB	4825	•	----	---			
	5	.420	140	B		•	----	---				----	---				----	---																		
16	1	----	---				----	---				----	---				----	---				.436	303	SB	4435	•	.470	530	B			.472	543	SB	4370	
	2	----	---				----	---				----	---				----	---				.430	181	SpT	5125	•	.429	259	SB		•	.488	268	SpT	5950	
	3	.450	83	B		•	----	---				----	---				----	---				.401	369	SB		•	.406	241	SB	6280	•	.467	375	SB		
	4	.430	174	B		•	.377	35	B	4290	•	----	---				----	---				.466	485	SpT			.442	494	SpT	6720		.412	361	SmT		
	5	.436	133	B	4960	•	.435	150	B		•	----	---				----	---				.407	873	SpT	5200		.390	536	SSpT			.395	284	SpT	4740	
	6	.393	54	B	4740	•	.416	81	B		•	.421	216	SSpT	4800	•	----	---				.410	301	SpT	6480		.400	293	SpT			.415	176	B	5020	
	7	.387	79	B		•	.382	54	B	4510	•	.394	85	B		•	.391	443	SpT	4860		.387	455	SpT			.370	509	SB			.374	208	SB		
	8	.339	31	B		•	.368	63	B		•	.392	22	B		•	.382	232	SpT	4420	•	.407	360	SmT			.386	318	SpT	4760		.398	---	K		
20	1	.582	174	B	4580	•	----	176	B		•	.476	322	B	3850	•	.468	311	SB		•															
	2	.486	205	B	5130	•	.453	253	SB		•	.445	216	B		•	----	242	SB		•															
	3	.423	104	B		•	.424	219	SSpT	4585	•	.429	265	B		•	.425	250	SSpT	4875	•															
	4	----	---				----	---				.447	391	SpT		•	.468	406	SpT	6900	•															
24	1	.435	384	SpT	6105	•	.418	527	SpT			.433	496	SmT	4710		.428	469	SpT			.426	505	SpT	5360		.436	582	SpT			.432	438	SpT	6775	
	2	.439	272	SpT	6015	•	.437	356	SpT		•	.435	349	SpT	6485		.439	347	SpT			.440	362	SpT	6425		.440	447	SpT			.432	297	SpT	6670	
	3	.429	51	B		•	.447	107	B	6030	•	.430	346	SpT		•	.443	596	SpT	6360		.424	498	SpT			.436	588	SpT	5060		.425	763	SpT		
	4	.427	53	B		•	.434	74	B	6005	•	.440	91			•	.459	447	SpT	7675		.439	478	SpT			.441	552		825		.464	484	SpT		
	5	----	---				----	---				----	---				----	---				.435	369	SpT	5585		.426	496	SpT			.418	612	SpT	6520	
	6	.409	22	B	4885	•	.428	51	B		•	----	---				.447	104	SB			.432	426	SpT	5340		.428	36				.436	364	SpT	6420	
	7	.342	14	B		•	.364	27	B	4625	•	.381	78	B		•	.388	78	B			.441	573	SpT			.411	581	SpT	6305		.377	456	SpT		
	8	----	---				.388	31	B	4530	•	----	61	B		•	----	385	SpT			.422	303	SpT			.412	294	SpT	6170		.409	378	SpT		
	9																					.389	390	SpT			.394	469	SpT			.397	549	SpT		

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
28	1	.415	126	B	5390	•	.404	188	SB		•	.414	518	SpT	5225		.426	565	SpT			.464	865	SpT	6280		.475	864	SpT			.445	784	SpT	5825	
	2	.427	56	B	5400	•	.429	85	B		•	.435	129	SB	5680	•	.431	344	SpT			.440	363	SpT	6560		.440	429	SpT			.432	423	SpT	6460	
	3	----	---				----	---				.409	91	B		•	.445	474	SpT		•	.418	354	SpT			----	---				.426	840	SpT		
	4	----	---				----	---				----	---				----	---				.435	405	SpT			----	---				----	---			
32	1	----	---				----	---				.479	795	SpT	5965		.471	28	SpT			.474	583	SpT	6760		.481	577	SpT			.504	896	SpT	6300	
	2	----	---				----	---				.467	287	SpT	6510	•	----	---				.459	724	SpT	6490		.447	397	SpT			.443	315	SpT	5465	
	3	.442	53	B		•	.431	106	B	5185	•	.430	332	SpT		•	.429	466	SpT	5965		.425	480	SpT			.423	556	SpT	6220		.432	554	SpT		
	4	.442	49	B		•	.428	135	B	5685	•	.445	145	SpT		•	.439	385	SpT	5385		.442	502	SpT			.444	365	SpT	6400		.448	452	SpT		
	5	.443	70	B	5400	•	.449	97	B		•	.454	236	SpT	6960	•	----	---				.462	575	SpT	7040		.461	298	SpT			.454	554	SpT	6960	
	6	.392	28	B	5360	•	.420	113	B		•	.394	67	B	4920	•	.413	163	SpT		•	.398	383	SpT	5545		.409	273	SpT			.402	427	SpT	6040	
	7	.413	25	B		•	.403	125	B	4710	•	.410	126	B		•	.421	284	SpT	6155	•	.426	531	SpT			.443	483	SpT	6340		.439	596	SpT		
	8	----	---				.386	42	B	5240	•	.397	53	B		•	.406	380	SpT	6075	•	.409	358	SpT			----	---				.415	305	SpT		
	9	.333	5	B	2370	•	.380	28	B		•	.389	24	B	4170	•	.418	68	B			.420	51	SpT	4540		----	---				----	---			
	10	----	---				.324	8	B		•	.336	7	B	3640	•	.360	28	SpT			----	---				----	---				----	---			
36	1	.434	539	SpT	5705		.453	596	SpT			.447	771	SpT	6240		.437	741	SpT			.457	600	SpT	5940		.493	559	SpT			.482	670	SpT	6780	
	2	.486	339	SpT	7330		.489	413	SpT			.493	351	SpT	6450		----	---				.438	337	SpT	5915		.457	333	SpT			.478	419	SpT		
	3	.484	599	SpT		•	.496	768	SpT	7005		.474	765	SpT			.465	675	SpT	250		.483	848	SpT			.477	582	SpT	7165		.488	579	SpT		
	4	.454	92	SB		•	.452	102	SpT	6935	•	.455	565	SpT		•	.463	507	SpT	6800		.450	510	SpT			.459	436	SpT	6860		----	---			
	5	.417	78	B	5290	•	.427	148	SpT		•	.429	871	SpT	5135		.440	121	SpT			.451	486	SpT	6440		.446	534	SpT			.428	339	SpT		
	6	----	---				.455	174	SpT		•	.466	737	SpT	7540		.464	434	SpT			.445	429	SpT	6500		.460	434	SpT			----	---			
40	1	----	413	SpT	6450		.499	800	SpT			.510	559	SpT	7240		.512	762	SpT			.501	584	SpT	7080		.490	588	SpT			.485	592	SpT	7005	
	2	.499	319	SpT	4840	•	.510	321	SpT			.489	426	SpT	7225		.501	387	SpT			.474	353	SpT	7320		.461	367	SpT			.482	367	SpT	7220	
	3	.449	376	SpT		•	.457	712	SpT	6560		.471	577	SpT			.454	422	SpT	270		.478	634	SpT			.469	536	SpT	7160		.466	459	SpT		
	4	.440	107	SpT		•	.449	519	SpT	6780		.452	478	SpT			.442	422	SpT	6660		.445	450	SpT			.443	358	SpT	6465		.437	378	SpT		
	5	.450	129	B	5985	•	.462	581	SpT			.448	588	SpT	6440		.458	396	SpT			.422	883	SpT	6265		.414	421	SpT			.435	850	SpT	6370	
	6	.420	99	SB	5780	•	----	---				.410	510	SpT	6220		----	---				418	355	SpT	5890		.419	341	SpT			.416	274	SpT	5760	
	7	.389	109	B		•	.390	67	B	4880	•	.396	395	SpT			----	---				.385	370	SpT			.393	488	SpT			----	---			
	8	----	---				----	---				.369	121	SpT		•	----	---				----	---				----	---				----	---			
44	1	.494	443	SpT	7420		.481	480	SpT			.491	837	SpT	6810		.508	584	SpT			.504	499	SpT	6790		.567	341	SpT			.498	596	SpT	7200	
	2	.496	---	K	6365		.501	442	SpT			.484	456	SpT	6760		.495	434	SpT			.501	397	SpT	7070		.495	457	SpT			.466	390	SpT	7210	
	3	----	---				.461	889	SpT	6850		.463	713	SpT			.451	470	SpT	6440		.466	559	SpT			.464	500	SpT	6380		.437	562	SpT		
	4	.467	222				.462	392	SpT	7225		.449	365	SpT			.465	463	SpT	6490		.442	355	SpT			.463	418	SpT	6690		.444	407	SpT		
	5	.446	160	SB	5805	•	.448	833	SpT			.456	580	SpT	6740		.458	582	SpT			.445	570	SpT	6520		.470	548	SpT			.443	478	SpT	6580	
	6	.410	99	SB	5640	•	.418	410	SpT			.404	389	SpT	5780		.396	394	SpT			.392	301	SpT	5465		----	---				.396	442	SpT	6135	
	7	.420	100	B		•	.431	358	SpT	5640	•	.421	513	SpT			.414	586	SpT	6040		.400	445	SpT			.443	341	SpT	5605		.388	318	SpT		
	8	.373	20			•	.379	69	B	5305	•	.392	286	SpT		•	.403	303	SpT	6415		----	---				----	---				----	---			
	9	----	---				.362	65	B		•	.360	178	SpT	1840	•	.373	247	SpT		•	----	---				----	---				----	---			
	10	.319	4	B	2950	•	.323	20	B		•	.336	22	B	1280	•	----	---				----	---				----	---				----	---			

M9178F

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
42	1	.482	515	SpT	7030		.476	567	SpT			.492	439	SpT	6850		.[illegible]					.[illegible]					----	---				.518	570	SpT	6210	
	2	.510	319	SSpT	7625		.509	355	SpT			.500	362	SpT	7840		.490	374	SpT			.462	349	SpT	7305		.498	318	SpT			.502	345	SpT	6880	
	3	.464	593	SpT			.460	664	SpT	6760		.463	496	SpT			.468	730	SpT	5780		.462	757	SpT			.440	501	SpT	6635		.453	565	SpT			
	4	.469	203	SpT		•	.470	166	SpT	7405		.495	370	SpT			.461	379	SpT	7000		.471	321	SpT			.450	371	SpT	6285		.454	326	SpT			
	5	.458	229	SpT	6970	•	.472	599	SpT			.470	489	SpT	7320		.468	454	SpT			.460	573	SpT	6850		.460	562	SpT			.452	487	SpT	7090	
	6	.404	78		6155	•	.408	296	SpT			.[illegible]	278	SpT	6370		.407	367	SpT			.412	285	SpT	4875		.412	373	SpT			.410	406	SpT	6005	
	7	.419	79	P		•	.417	375	SpT	5900	•	.422	456	SpT			.432	461	SpT	6620		.396	339	SpT			.420	390	SpT	115		.416	468	SpT			
	8	.349	27	B		•	.354	46	B	5260	•	.355	270	SpT		•	.377	329	SpT	4700		.390	218	SpT			.380	278	SpT	5480		.392	355	SpT			
	9	.384	18	B	5205	•	.437	87	B		•	.404	341	SpT		•	.380	357	SpT			.401	364	SpT			.385	370	SpT			----	---				
	10	.371	9	B	4320	•	.367	62	B		•	----	---				----	---				----	---				----	---				----	---				
44	1	.531	464	SpT	7900		.528	732	SpT			----	---				.554	784	SpT			.532	317	SpT	7500		.512	772	SpT			.504	560	SpT	7785	
	2	.495	335	SpT	6905		.479	339	SpT			.482	392	SpT	7340		.478	400	SpT			.471	265	SpT	7225		.464	349	SpT			.479	272	SXg	6900	
	3	.477	458	SpT		•	.474	541	SpT	7360		.476	591	SpT			.472	557	SpT	6680		.478	531	SpT			.488	470	SpT	7290		.484	456	SpT			
	4	.433	106	SpT		•	.435	492	SpT			.444	460	SpT			.442	400	SpT	6005		.456	522	SpT			.441	325	SpT	6735		.450	281	SpT			
	5	.421	93	SB		•	.441	870	SpT			.446	559	SpT			.447	806	SpT			.[illegible]	440	SpT			.445	396	SpT			.434	370	SpT	6850	
	6	----	---				----	---				----	---				----	---				----	---				----	---				.420	264	SpT	5940	
48	1	.479	825	SpT	6970		.475	723	SpT			.464	743	SpT	6300		.466	732	SpT			.470	786	SpT	5875		.473	555	SpT			.459	458	SpT	6860	
	2	.497	355	SpT	7405		.458	322	SpT			.467	420	SpT	7140		.469	326	SpT			.471	358	SpT	6860		.481	478	SpT			.476	361	SpT	6700	
	3	.462	109	SpT		•	.455	559	SpT	6320		.457	508	SpT			.451	528	SpT	6285		.445	425	SpT			.448	2[illegible]	SXg	62 15		.453	765	SpT			
	4	.443	74	B		•	.450	97	SB	6620	•	.452	502	SpT			.471	421	SpT	5760		.452	403	SpT			.470	284	SpT	6960		.446	430	SpT			
	5	.468	78	B	6050	•	.474	173	SB		•	.476	400	SpT	7245		.495	506	SpT			----	---				.502	221	K			.500	553	SpT	6350	
	6	.410	69	B	5420	•	.400	83	SB		•	.406	401	SpT	6360		.406	296	SpT			---	---				----	---				.418	310	SpT	5840	
	7	----	---				----	---				.432	592	SpT		•	.438	478	SpT	6240		.457	420	SpT			----	---				.429	550	SpT			
	8	.350	9	B		•	.373	40	B	4795	•	.386	395	SpT		•	.408	374	SpT	5965		----	---				----	---				----	---				

Notes:-

1
Based on oven dry weight and volume as tested (air dry).

2
Nominal size of specimens:-
Toughness - 3/4 by 3/4 by 17 inches.
Compression-parallel-to-grain - 3/4 by 3/4 by 3-1/2 inches

The moisture content of most specimens were included within a range of 12 to 14.5 per cent.

Odd numbered toughness specimens were tested with load applied on tangential surface and even numbered specimens with load applied on radial surface.

3
Legend
SpT = Splintering tension
SSpT = Slight splintering tension
B = Brash
SB = Slightly brash
Xg = Cross-grained
SXg = Slightly cross-grained
SmT = Simple tension
HS = Horizontal shear
• = Infected

Shipment No. 987 - Tree No. 9.

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
MADISON, WISCONSIN
PROJECT 243-J1 April 28, 1925.

M9799F

Table 2.

Tabular diagrammatic presentation of toughness and compression parallel to grain test results; tree 3, Sitka spruce, infected with Trametes pini. The data in this table have been arranged in diagrammatic form to show the relative position of each specimen within a board. Each infected specimen is indicated by a black dot, to bring out clearly the region of infection within a board. The relative cross-sectional position of each board is shown in figure 1, A.

Table 2.

Tabular discrepancies (transcriptions
of thoughtless and unprocessed material to
great tedium result type 3. Within everyday
interests with [illegible word]. The data in
this table have been arranged in chronological
form to show the relative [illegible] of each
operation within a month. Each [illegible] appli-
cation is indicated by a plus dot. To obtain ord
clearly the [illegible] of [illegible] within a month.
The relative expenditures [illegible] of each
[illegible] is shown in figure 1, A.

Table 2.--Tabular diagrammatic presentation of toughness and compression-parallel-to-grain test results.

Tree species: Sitka spruce

Fungus species: Trametes pini

Board No.	Specimen No.	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]
		Bolt A-1					A-2					A-3					P-1					P-2				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
2	1	.384	290	SXg	5240	•	.392	251	SpT		•	.391	257	SmT	4940	•	----	---				.406	325	SpT	5150	•
	2	.400	222	SXg	5100	•	.407	255	SXg		•	.409	206	SmT	5180	•	----	---				.416	230	SpT	6280	•
	3	.421	288	SXg			.425	268	SXg	6260	•	.421	367	SpT		•	----	---		5700		.420	383	SpT		•
	4	----	---				.425	230	SmT	4970		.433	295	SmT			.417	242	SXg	5580		.418	232	SSpT		•
	5	.410	357	SXg	5100		.426	365	SpT			.420	386	SpT	5080		.431	306	SXg			.430	344	SSpT	5500	•
	6	----	---		5[illegible]		.429	292	SmT			.440	296	SmT	5160		.410	310	SpT			.414	223	SXg	5920	•
4	1	.416	333	SpT	5030		.400	241	SpT		•	.405	266	SpT	5440	•	.417	282	SpT		•	.404	260	SpT	4320	•
	2	.428	311	SpT			.406	177	SXg		•	.403	162	SXg	5820	•	.401	244	SXg		•	.406	234	SpT	5490	•
	3	.408	274	SpT	4690		.404	389	SpT	6050		.417	388	SpT		•	.407	479	SpT	5600	•	.411	328	SpT		•
	4	----	---				.402	231	SpT	5940		.412	197	SXg		•	.419	222	SXg	5580	•	.418	301	SpT		•
	5	----	---		4140		.420	460	SpT			.428	329	SpT	5440	•	.421	475	SpT		•	.431	391	SpT	6090	•
	6	----	---		5735		.433	212	SXg			.446	225	SXg	5840	•	.437	195	SmT		•	.426	248	SXg	6410	•
6	1	.414	200	SpT	5480	•	.415	266	SpT		•	.430	246	SpT	4780	•	.408	185	SmT		•	.405	149	SSpT	5150	•
	2	.405	240	SpT	5105	•	.408	202	SmT		•	.413	225	SpT	4910	•	.410	208	SXg		•	.401	183	SpT	5470	•
	3	.413	268	SpT			.415	365	SpT	5780		.426	253	SpT		•	.417	281	SSpT	4940	•	.431	186	SSpT		•
	4	.419	321	SpT			----	---				----	---				.433	201	SXg	5540		.441	278			
	5	.418	219	SpT	5810		.421	334	SpT			----	---				.451	240	SXg			.501	581	SpT	6580	
	6	.432	276	SXg	5800		----	---				----	---				.451	262	SXg			.435	215	SXg	6400	
8	1	.408	300	SpT	5520	•	.400	341	SpT			.406	244	SXg	5540	•	.417	223	SpT		•	.441	250	SmT	4350	•
	2	.427	200	SmT	4690	•	.404	217	SXg			.403	227	SpT	5770	•	.403	258	SpT		•	.435	166	SmT	5300	•
	3	.428	311	SpT		•	.416	359	SpT	5105	•	.424	217	SmT		•	.433	389	SpT	5170	•	----	---			
	4	.434	257	SXg			.416	176	SXg	4990	•	.438	210	SXg		•	.430	213	SpT	5605	•	.481	42			•
	5	.422	298	SpT	5745		.446	512	SpT			.414	323	SXg	6660	•	.532	375	SpT		•	----	---			
	6	.428	241	SXg	5920		.433	284	SpT			.430	140	SXg	5870		.465	240	SmT			.454	298	SXg	6490	
10	1	.416	232	SmT	5425		.414	287	SpT			.409	246	SpT	4860		.419	324	SpT			.410	500	SpT	5890	•
	2	.409	225	SpT	5800		.398	223	SpT		•	.404	190	SXg	5460	•	.413	221	SmT		•	.402	264	SpT	5220	•
	3	.421	336	SpT			.423	366	SpT	5895	•	.417	265	SXg		•	.436	366	SpT	5540	•	.414	292	SpT		•
	4	.470	316	SpT			.416	229	SXg	5875		.431	238	SpT		•	.471	255	SmT	5315	•	.427	278	SpT		•
	5	.434	328	SpT	5750		.452	338	SpT			.426	301	SXg	6270		.440	358	SXg			.442	264	SpT	5520	
	6	.436	207	SXg	6360		.459	275	SXg			.472	243	SmT	7090		.471	292	SXg			.451	232	SpT	6040	
12	1	.397	291	SpT	4865		.406	267	SpT			.401	321	SpT	5125		.397	302	SpT		•	.400	240	SmT	5445	•
	2	.413	225	SXg	5395		.410	193	SXg			.404	228	SpT	5560		.407	201	SmT			.405	196	SmT	5960	•
	3	.426	369	SpT			.414	313	SpT	5750		.420	378	SpT		•	.426	361	SpT	5695	•	.411	324	SpT		•
	4	.425	237	SpT			.438	295	SmT	5760		.448	242	SpT		•	.435	241	SmT	6345	•	.440	251	SXg		•
	5	.470	372	SpT	6080		.451	380	SpT			.449	320	SpT	5860		.433	389	SpT			.444	282	SpT	5595	•
	6	.461	324	SXg	6000		.430	231	SXg			.449	202	SXg	5990		.470	234	SXg			.447	193	SXg	5065	•
14	1	.394	274	SmT	4810		.401	266	SmT			.403	375	SpT	5140	•	.390	268	SpT		•	.390	345	SpT	5030	•
	2	.405	176	SpT	5525		.397	159	SmT			.399	162	SpT	4570		.400	190	SXg			.397	243	SpT	5165	•
	3	.439	498	SpT			.418	169	SpT	5440		.427	347	SpT			.425	238	SpT	5730		.423	314	SpT		•
	4	.474	281	SpT			.451	221	SmT	6280		.436	206	SpT			.430	296	SpT	5950		.429	219	SpT		•
	5	.476	458	SpT	6320		.424	373	SpT			.434	359	SpT	5875		.425	246	SpT			.423	311	SpT	4985	
	6	.448	231	SXg	6010		.442	208	SmT			.446	182	SXg	6130		.451	187	SXg			.449	297	SXg	5825	
16	1	.420	269	SpT	5955		.423	301	SpT			.429	467	SpT	5540		.440	383	SpT			.417	293	SmT	5540	
	2	.438	256	SpT	6200		.423	221	SmT			.428	224	SXg	6220		.443	319	SpT			.427	267	SmT	5900	
	3	.442	378	SpT			.436	358	SpT	5940		.434	434	SpT			.446	297	SpT	5840		.441	341	SpT		
	4	.436	291	SmT			.431	291	SpT	6120		.420	242	SpT			.430	232	SpT	5530		.446	243	SpT		
	5	.444	238	SmT	5830		.446	610	SpT			.440	470	SpT	5880		.436	371	SpT			.472	472	SpT	5705	
	6	.441	221	SmT	6240		.453	245	SpT			.455	222	SXg	5005		.441	273	SpT			----	---			
18	1	.429	374	SpT	5040		.420	466	SpT			.408	342	SpT	6140		.411	379	SpT			.394	335	SpT	5800	
	2	.417	244	SpT	5840		.419	264	SpT			.416	252	SpT	5540		.428	243	SpT			.421	339	SpT	5619	
	3	.434	495	SpT			.425	393	SpT	6120		.439	445	SpT			.459	383	SpT	5840		.463	422	SpT		
	4	.439	291	SXg			.433	233	SXg	5620		.442	238	SpT			.429	223	SpT	5320		.426	255	SpT		
	5	.416	371	SXg	4465		.432	31	SpT			.428	366	SpT	3925		.441	464	SpT			.433	389	SpT	6010	
	6	.442	266	SpT	5270		.447	246	SpT			.409	275	SpT	5490		.423	236	SpT			.428	232	SmT	5225	
22	1	.419	254	SmT	5750		.420	382	SpT			.431	386	SpT	5100		.421	498	SpT			.410	441	SpT	5035	
	2	.443	256	SmT	6180		.443	239	SmT			.421	259	SpT	5320		.412	297	SpT			.403	260	SmT	4630	
	3	.435	531	SpT			.412	264	SpT	4770		.423	306	SpT			.426	466	SpT	5805		.424	291	SpT		
	4	.439	237	SXg			.405	214	SmT	5060		.420	200	SmT			.429	273	S_T	5860		.425	234	SpT		
	5	.442	389	SpT			.433	651	SpT			.443	365	SpT	6030		.427	510	SpT			.421	424	SpT	4530	
	6	.454	223	SB	6180		.445	257	SXg			.457	242	SXg	5845		.432	269	SpT			.435	217	SB	4670	

M980F See footnotes page 4.

Table 2.--Tabular diagrammatic presentation of toughness and compression-parallel-to-grain test results.

Tree species: Sitka spruce

Fungus species: Trametes pini

Board No.	Specimen No.	Bolt B-3					C-1					C-2					C-3					D-1				
		Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]	Specific gravity[1]	Toughness (in. lbs. per specimen)[2]	Type of failure[3]	Maximum crushing strength in compression-parallel-to-grain (lbs. per sq. in.)[2]	Infected[3]
28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
2	1	.410	342	SpT		●	.402	212	SpT	5100	●	.382	222	SmT		●	.327	33	B	2220	●	.469	180	SSpT		●
	2	.405	187	SmT		●	.414	242	SpT	5720	●	.402	198	SpT		●	.405	113	Xg	4600	●	.317	107	B		●
	3	.413	325	SpT	4840	●	.403	386	SpT		●	.381	188	SpT	4220	●	.339	84	SSpT		●	.396	141	SXg	4830	●
	4	.418	193	SXg	5580	●	.414	187	SXg		●	.402	171	SXg	4450	●	.378	29	Xg		●	.425	190	SXg	4880	●
	5	.461	284	SpT		●	.435	305	SpT	5890	●	.372	315	SpT		●	.444	88	B	3550	●	.392	181	SSpT		●
	6	.510	198	SpT			.434	270	SXg	5095	●	.402	132	SXg		●	.393	36		2890	●	.412	175	SSpT		●
4	1	.408	287	SpT		●	.365	85	B	3660	●	.268	28	B		●	----	---				.550	107	B		●
	2	.395	187	SpT		●	.466	221	SSpT	5900	●	.384	261	SpT		●	----	---				.268	56	SSpT		●
	3	.416	388	SpT	5830	●	.412	433	SpT		●	.418	438	SpT	5550	●	.285	5	B		●	.400	201	SSpT	4810	●
	4	.396	197	SpT	4540	●	.396	175	SSpT		●	.358	97	SmT	3310	●	.262	12			●	.430	265	SpT	5120	●
	5	.420	279	SpT		●	.415	266	SpT	5210	●	.388	159	SSpT		●	.259	2	B	1303	●	.406	153	SSpT		●
	6	.432	171	SXg		●	.434	144		5690	●	----	---				.299	18	B	2550	●	.443	251	SpT		●
	7	----	---				.410	378	SSpT		●	.384	147	SmT		●	.370	66	B		●	----	---			
6	1	.411	115	SB		●	.388	159	SB	4290	●	.574	117	B		●	.800	233	SmT	4550	●	.460	294	SpT		●
	2	.390	153	SXg		●	.363	63	SmT	3450	●	.312	45	B		●	----	6		94		.411	202	SXg		●
	3	.435	229	SpT	4800	●	.374	136	SSpT		●	.340	72	B	3450	●	----	0				.410	185	SpT	5620	●
	4	.452	275	SpT	5640	●	.419	232	SmT		●	.357	44	B	2130	●	.279	25	B		●	.398	132	SmT	5600	●
	5	.546	353	SpT		●	.452	322	SXg	6160	●	.450	81	B		●	.272	16	B	1145	●	.436	446	SpT		●
	6	.438	188	SpT		●	.449	185	SXg	5375	●	.452	191	SXg		●	.378	67	B	4510	●	.434	311	SpT		●
8	1	.492	280	SpT		●	.631	286	SmT	4390	●	.664	362	SpT		●	.404	271	SB	4475	●	.652	333	SpT		●
	2	.526	230	SXg		●	.644	225	SmT	4940	●	.410	208	SpT		●	.405	248	SpT	4810	●	.384	79	B		●
	3	.403	256	SpT	4660	●	.410	270	SmT		●	.364	183	SpT	3530	●	.314	55	B		●	.405	140	SpT	4815	●
	4	.418	145	SXg	4440	●	.372	76	SXg		●	.371	87	SXg	3980	●	.400	264			●	.415	138		5090	●
	5	.480	379	SpT		●	.434	327	SpT	5950	●	.411	168	SpT		●	.398	222	SpT	5100	●	.443	239	SpT		●
	6	.449	253	SXg			.457	203		6660	●	.450	169	SXg		●	.433	281	SpT	6265	●	.431	297	SpT		●
10	1	.412	360	SpT			.412	446	SpT	5725	●	.413	464	SpT		●	.408	372	SpT	5895	●	.404	296	SpT		●
	2	.421	224	SpT			.390	148	SXg	4885	●	.401	180	SXg		●	.400	159	SmT	4645	●	.415	241	SpT		●
	3	.429	307	SpT	5640		.415	285	SpT		●	.401	286	SmT		●	.348	63	B		●	.421	354	SpT	5910	●
	4	.414	369	SXg	4810	●	.406	215	SpT		●	.389	156	SpT	4820	●	.361	112	B		●	.439	210	SpT	5050	●
	5	.440	217	SpT			.418	356	SpT	6150	●	.417	303	SpT		●	.474	173	SmT	6340	●	.429	345	SpT		●
	6	.436	221	SXg			.449	250	SmT	5890	●	.429	216	SXg		●	.466	119	SXg	4980	●	.433	362	SpT		●
12	1	.400	437	SpT		●	.397	243	SpT	4580	●	.421	296	SpT		●	.403	315	SpT	4555		.399	221	SpT		●
	2	.399	238	SmT		●	.406	319	SpT	5230	●	.416	236	SpT		●	----	---		4555		.416	233	SpT		●
	3	.435	360	SpT	5740	●	.431	391	SpT		●	.433	370	SpT	5390	●	.413	133	B		●	.423	461	SpT	5880	●
	4	.431	295	SpT	5860	●	.439	161	SB		●	.438	256	SpT	4825	●	.422	301	SpT		●	.416	261	SpT	5430	●
	5	.431	360	SpT			.444	339	SmT	5825	●	.448	336	SpT		●	.434	296	SpT	5080	●	.428	542	SpT		●
	6	.459	391	SpT		●	.455	202	SB	5635	●	.462	207	SmT		●	.445	227	SmT	5220	●	.433	343	SpT		●
14	1	.389	300	SpT		●	.393	251	SmT	5260	●	.391	337	SpT		●	.427	220	SmT	4880	●	.437	230	SXg		
	2	.429	252	SpT		●	.416	255	SmT	5550	●	.419	248	SmT		●	.415	291	SmT	5815		.414	190	SXg		
	3	.434	354	SpT	5420	●	.433	465	SpT		●	.426	356	SpT	5785	●	.422	365	SpT		●	.411	350	SpT	5740	
	4	.427	210	SpT	5135	●	.420	221	SmT		●	.421	185	SXg	5510	●	.432	210	SmT		●	.429	272	SXg	5360	
	5	.412	208	SpT		●	.424	367	SpT	5450	●	.455	411	SpT			.444	360	SpT	5920	●	.434	370	SpT		
	6	.441	202	SpT		●	.476	233	SB	6165	●	.447	216	SXg		●	.440	168	SXg	5790		.433	223	SXg		
16	1	----	---				.412	339	SpT	5705		.424	309	SpT			.439	422	SpT	5795		.436	259	SXg		
	2	----	---				.421	495	SpT	5610		.420	242	SmT			.424	337	SpT	6225		.424	280	SpT		
	3	----	---				.419	340	SpT			.426	436	SpT	6140		.431	214	SpT			.427	302	SXg	5875	
	4	----	---				.413	222	SXg			.417	209	SmT	5480		.426	284	SmT			.427	206	SpT	5720	
	5	----	---				.456	361	SXg	6135		.467	354	SpT			.449	532	SpT	5740		.426	477	HS		
	6	.550	50				.437	421	SpT	5260		.421	206	SpT			.421	251	SmT	5810		.416	214	SpT		
18	1	.404	294	SpT			.418	418	SpT	6020		.415	386	SpT			.418	437	SpT	5980		.425	381	SpT		
	2	----	---				.422	296	SpT	5920		.410	256	SpT			.418	253	SpT	5990		.419	224	SXg		
	3	----	---				.423	321	SpT			.407	520	SpT	5350		.408	266	SpT			.421	414	SpT	5675	
	4	----	---				.432	311	SpT			.429	206	SpT	5595		.439	306	SpT			.416	237	SpT	5500	
	5	----	---				.446	330	SpT	5990		.435	283	SpT			.441	350	SpT	5865		.421	554	SpT		
	6	----	---				.425	314	SXg	4865		.434	283	SpT			.440	273	SpT	6000		.431	251	SpT		
22	1	.387	323	SpT			.411	392	SpT	5145		.408	331	SpT			.413	258	SpT	5660		.446	260	SpT	6270	
	2	.414	223	SpT			.421	367	SpT	5710		.427	333	SpT			.435	241	SXg	5500		.447	343	SpT	6280	
	3	.420	296	SpT	5900		.426	371	SpT			.423	375	SpT	5770		.446	187	SXg			.432	496	SpT		
	4	.412	208	SpT	5205		.440	293	SpT			.416	251	SpT	6080		----	---				.448	264	SpT		
	5	.431	305	SpT			.430	328	SpT	4900		.428	306	SpT			----	---				.430	343	SpT	5740	
	6	.434	207	SpT			.429	330	SpT	5100		.430	197	SpT			----	---		5760		.445	315	SpT	5280	

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		Bolt A-1					A-2					A-3					B-1					B-2				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
26	1	.448	523	SpT	5940		.442	364	SpT			.439	392	SpT	6110		.439	417	SpT			.441	391	SpT	5980	
	2	.444	550	SpT	6110		.444	257	SpT			.443	306	SpT	5870		.439	278	SpT			.441	379	SpT	5975	
	3	.447	300	SpT			.434	369	SpT	5790		.436	414	SpT			.427	360	SpT	5700		.423	260	SpT		
	4	.424	293	SpT			.430	216	SpT	5915		.423	264	SpT			.437	238	SpT	6010		.440	221	SpT		
	5	.436	432	SpT	5150		.431	609	SpT			.424	324	SpT	5490		.418	300	SpT			.426	481	SpT	6105	
	6	.424	326	SpT	5280		.447	233	SpT			.444	263	SpT	5660		.412	272	SpT			.416	256	SpT	5580	
30	1	.464	396	SpT	6660		.448	269	SXg			.445	425	SpT	6090		.438	356	SpT			.439	346	SpT	6075	
	2	.458	263	SpT	6295		.420	188	SXg			.422	252	SpT	5940		.424	294	SpT			.426	339	SpT	6090	
	3	.413	340	SpT			.417	442	SpT	5820		.414	357	SpT			.424	304	SXg	5975		.419	446	SpT		
	4	.415	295	SpT			.422	252	SmT	5875		.436	273	SpT			.435	244	SpT	5665		.427	391	SmT		
	5	.424	316	SpT	5970		.418	309	SpT			.420	356	SpT	5920		.412	369	SpT			.417	340	SpT	5905	
	6	.438	273	SpT	5855		.429	306	SmT			.419	248	SpT	5820		.422	346	SpT			.421	272	SXg	5875	
34	1	.442	411	SpT	5945		.452	315	SpT			.446	451	SpT	6065		.442	389	SpT			.437	563	SpT	6080	
	2	.416	248	SXg	5915		.437	304	SpT			.442	299	SpT	6110		.441	411	SpT			.438	264	SmT	6020	
	3	.417	411	SpT			.434	371	SpT	6150		.415	268	SpT			.426	298	SpT	6060		.427	315	SpT		
	4	.455	277	SXg			.412	330	SpT	5980		.428	340	SpT			.418	224	SpT	6030		.424	252	SpT		
	5	.427	303	SmT	6110		.411	362	SpT			.411	298	SpT	5930		.404	341	SpT			.427	348	SpT	5720	
	6	.409	224	SmT	4400		.407	240	SpT			.415	259	SpT	6080		.427	256	SpT			.456	293	SpT	6090	
38	1	.445	494	SpT	5810		.446	373	SpT			.420	495	SpT	6040		.456	356	SpT			.432	245	SpT	6480	
	2	.429	334		5450		.454	327	SpT			.440	284	SpT	6210		.440	242	SXg			.446	270		5980	
	3	.442	328	SpT			.434	355	SpT	5985		.449	398	SpT			.448	356	SpT	6410		.450	252	SpT		
	4	.427	240	SXg			.427	260	SpT	6040		.452	282	SpT			.423	244	SmT	5940		.449	263	SSpT		
	5	.462	350	SpT	6050		.461	429	SpT			.459	521	SpT	6660		.440	470	SpT			.440	346	SpT	5970	
	6	.440	288	SXg	6495		.447	344	SpT			.451	323	SpT	6230		.457	330	SXg			----	---			
42	1	.444	432	SpT	5990		.446	407	SpT			----	---				.453	378	SXg			.434	286	SXg	6265	
	2	.435	268	SpT	5940		.451	222	SmT			----	---				.428	284	SpT			.428	231	SmT	5955	
	3		272	SSpT			.438	324	SpT	6010		----	---				.458	315	SpT	6270		.443	374	SpT		
	4	.431	336	SpT			.448	232	SXg	5935		----	---				.424	267	SXg	5970		.435	249	SXg		
	5	.412	258	SXg	6160		.448	388	SpT			----	---				.438	298	SXg			.424	256	SpT	5730	
	6	.434	324	SXg	6700		.455	229	SXg			----	---				.441	269	SXg			.434	271	SXg	5930	
46	1	.439	502	SpT	5980		.428	390	SpT			.458	407	SpT	6330		.434	528	SpT			.439	350	SpT	4745	
	2	.427	235		6070		.428	272	SXg			.414	304	SpT			.411	209	SpT			.424	241	SmT	4480	•
	3	.430	376	SpT			.432	416	SpT	5730		.452	474	SpT	4980		----	---				----	---			
	4	.451	299	SmT			.424	240	SXg	5940		.428	255	SpT			.419	284	SmT	5980		.439	209	SXg		
	5	.413	377	SpT	6040		.446	425	SpT			.447	681	SpT	5980		.454	518	SpT			.440	452	SpT	4970	
	6	.441	322	SpT	5955		.428	189	SXg			.419	328	SXg	4740		.430	254	SXg			.424	248	SXg	4550	
50		.427	311	SpT	5880	•	----	---				.405	267	SpT	5975	•	.424	338	SpT		•	.420	304	SpT	5420	•
		.429	231	SSpT	5990		.388	271	SXg		•	.430	132	SXg	5430		.450	253	SmT		•	.415	250	SpT	5810	•
		----	---				.436	421	SpT	5980		.417	225	SXg			.415	242	SXg	6310		.431	402			•
		----	---				.400	242	SXg	5905		.416	222	SmT			.417	248	SmT	5965		.422	220	SXg		•
		----	---				.423	353	SXg			.423	376	SXg	5980		.430	338	SXg			.438	400	SpT	5120	
		.402	292	SXg	5880		.425	267	SXg			.435	230	SXg	5470		.425	242	SXg			.412	201	SXg	5580	
54	1	.411	307	SpT	5920	•	.411	386	SpT		•	.440	275	SpT	5320	•	.404	189	SSpT		•	.397	316	SpT	5125	•
		.399	181	SXg	6190		.394	176	SXg		•	.426	246	SmT	5305	•	----	---				.411	181	SpT	5885	•
		.416	341	SpT			.430	478	SpT	6040		.411	474	SpT		•	.442	260	SmT	6070	•	.434	434	SpT		•
		.426	216	SXg			.416	318	SXg	5730		.426	224	SXg			----	---				.475	354	SpT		•
		.415	333	SpT	6160		.412	300	SpT			.407	170	SpT	5980		.421	342	SXg			.437	421	SpT	5940	
		.419	197	SXg	6040		.417	263	SXg			----	---				.434	218	SpT			.454	297	SXg	6140	•

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		Bolt B-5					C-1					C-2					C-3					D-1				
28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
26	1	.400	478	SpT			.449	446	SpT	5690		.444	406	SpT			.445	388	SpT	5910		.436	335	SpT		
	2	.435	268	SpT			.429	233	SpT	6300		.424	264	SmT			.434	350	SpT	5930		.424	202	SXg		
	3	.433	238	SpT	5630		.416	481	SpT			.435	625	SpT	5975		.433	330	SpT			.425	345	SpT	5285	
	4	.433	270	SpT	5590		.418	322	SpT			.415	244		5330		.419	259	SpT			.432	278	SXg	5910	
	5	.420	274				.412	460	SpT	5700		.417	334	SpT			.433	391	SpT	5410		.429	400	SpT		
	6	.444	379	SpT			.426	231	SpT	5565		.426	212	SXg			.443	303	SpT	5745		.414	271	SXg		
30	1	.429	322	SpT			.435	326	SpT	5740		.416	358	SpT			.442	414	SpT	6080		----	---			
	2	.443	338	SpT			.441	243	SXg	4886		.446	299	SpT			.454	303	SpT	6295		----	---			
	3	.424	521	SpT	5190		.429	468	SpT			.475	459	SpT	6400		.451	261	SpT			----	---			
	4	.427	229	SXg	5825		.437	283	SmT			.518	292	SXg	6900		.463	315	SpT			----	---			
	5	.419	390	SpT			.427	333	SpT	5400		.509	382	SpT			.422	278	SpT	6330		----	---			
	6	.423	230	SpT			.451	204	SXg	5165		.479	382	SXg			.429	296	SXg	5500		----	---			
34	1	.439	357	SpT			.449	399	SpT	6610		.442	309	SpT			.455	317		5860		.464	485	SpT		
	2	.436	267	SpT			.432	350	SmT	5330		.433	235	SpT			.449	270	SpT	6580		.449	324	SpT		
	3	.419	376	SpT	5720		.427	436	SpT			.455	374	SpT	5975		.429	167	SpT			.469	521	SpT	6720	
	4	.425	281	SpT	5790		.425	344	SmT			.424	518	SpT	5480		.451	275	SpT			.450	313	SpT	6635	
	5	.452	475	SpT			.445	356	SpT	5520		.434	530	SpT			.441	500	SpT	6480		.456	427	SpT		
	6	.480	550	SpT			.442	224	SmT	6020		.468	275	SpT			.470	333	SpT	6340		.443	385	SpT		
38	1	.451	333	SpT			.458	277	SXg	6210		.448	324	SXg			.472	384	SpT	5900		.447	395	SpT		
	2	.435	269	SmT			.433	227	SXg	6240		.444	258	SSpT			----	---		6680		.455	412	SpT		
	3	.438	384	SpT	5620		.435	413	SXg			.428	375	SXg	5630		.451	281	SXg			.442	314	SpT	6220	
	4	.408	298	SXg	5635		.420	221	SXg			.415	215	SSpT	6040		----	---				.433	348	SpT	6140	
	5	.446	360	SXg			.425	349	SpT	6060		.423	340	SXg			----	---		6680		.441	349	SpT		
	6	.425	240	SXg			.444	246	SmT	6295		.447	266	SSpT			.470	191	SXg	5980		.448	306	SmT		
42	1	----	---				.425	159	SpT	5975		.435	358	SmT			.427	348	SXg	5935		.434	443	SpT		
	2	----	---				.430	279	SmT	5850		.433	229	SXg			.427	216	SXg	5940		.434	302	SXg		
	3	.426	464		5905		.436	376	SpT			.432	289	SpT	6415		.435	343	SXg		•	.438	474	SpT	5725	
	4	.443	259	SXg	6280		.445	241				.434	220	SXg	1865		.434	408	SpT		•	.421	490	SXg	5105	
	5	.441	365	SpT			.437	372	SXg	5[illegible]		.418	344	SpT			.427	329	SpT	6550		.423	360	SpT		
	6	.451	284	SXg			.434	254	SXg	6790		.427	264	SXg			.413	220	SpT	5400		.422	230	SXg		
44	1	.455	433	SpT		•	.459	235	SXg	5420	•	.445	435	SpT		•	.428	352	SpT	5645	•	.427	477	SXg		•
	2	.422	222	SSpT		•	.433	241	SXg	1530	•	.411	324	SpT		•	.414	215	SmT	5345	•	.438	194	SXg		•
	3	----	---				.432	444	SpT		•	.417	474	SpT	4426	•	.434	391	SpT			.434	544	SpT	5140	•
	4	.443	249	SXg	[illegible]		.455	514	SpT			.442	221	SXg	6150		.438	308	SpT			.440	129	SXg	5570	•
	5	.427	311	SpT			.432	369	SpT	4430		.419	361	SpT			.418	366	SpT	6065	•	.434	417	SpT		•
	6	.441	246	SXg			----	---				.426	188	SXg		•	.441	297	SXg	5090	•		243	SpT		•
46		.408	321	SSpT		•	----	---				.424	318	SpT		•	----	---				.409	434	SSpT		•
		.415	248	SpT		•	----	---				.416	194	SpT		•	----	---				.421	125	SSpT		•
		.408	349	SpT	5965	•	----	---				.380	120	SpT	4610	•	----	---				.415	242			•
	4	.410	249	SXg	6820	•	----	---				.427	388	SpT	5740	•	----	---				.408	188	SSpT	1400	•
	5	.420	398	SpT			----	---				----	---				----	---				.397	146	SSpT		•
	6	.414	239	SXg		•	.419	212	SpT	5[illegible]	•	----	---				----	---				.424	134	SmT		•
48	1	.398	300	SpT		•	.400	229	SpT	6005	•	.398	243	SXg		•	.378	71	B	3[illegible]	•	.378	142	SB		•
	2	.427	229	SpT		•	.416	218	SmT	5425	•	.402	106	SSpT		•	.378	79	B	3700	•	.407	242	SmT		•
	3	.441	461	SpT	5280	•	.426	400	SpT		•	.428	344	SpT	5175	•	.425	174	B		•	.428	471	SpT	5065	•
	4	.438	442	SpT	5880	•	.435	283	SXg		•	.424	214	SXg	6295	•	.394	41	B		•	.402	171	SXg	4500	•
	5	.420	422	SpT		•	.434	414	SpT	5445	•	.424	275	SpT		•	.377	87	B	4810	•	.421	189	SmT		•
	6	.424	251	SmT		•	.433	258	SmT	6015	•	.419	217	SXg		•	.414	93	B	4[illegible]	•	.416	267	SXg		•

Notes:-

1
Based on oven dry weight and volume as tested (air dry)

Shipment No. 987 - Tree No. 3.

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
Madison, Wisconsin
PROJECT 243-J1 April 28, 1948

2
Nominal size of specimens:-
Toughness - 3/4 by 3/4 by 17 inches.
Compression-parallel-to-grain - 3/4 by 3/4 by 3-1/2 inches.

The moisture content of most specimens were included within a range of 12 to 14.5 per cent.

Odd numbered toughness specimens were tested with load applied on tangential surface and even numbered specimens with load applied on radial surface.

3
Legend
SpT = Splintering tension
SSpT = Slight splintering tension
B = Brash
SB = Slightly brash
Xg = Cross-grained
SXg = Slightly cross-grained
SmT = Simple tension
HS = Horizontal shear
• = Infected

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Variation in Results, and Method of Selecting Control Specimens

The individual results from the toughness and compression parallel to grain tests are presented in Table 1 for the material infected with Polyporus Schweinitzii and in Table 2 for the material infected with Trametes pini.

It will be noted that a rather consistent difference between the toughness values for odd and even numbered specimens exists, the odd numbered rating considerably higher. This difference is due primarily to the testing prodedure and will be discussed later (see p. 15-17). In the futher presentation of the data this difference has been eliminated by the reduction of toughness test values to a percentage basis.

Aside from the difference between odd and even numbered specimens, the data of Tables 1 and 2 exhibit a wide range in properties of individual specimens, both sound and infected. The large variation in the weight and strength of wood, as shown not only by Tables 1 and 2 but by all data on tests of wood, renders the problem of measuring the effect of fungous attack an intricate one. It is quite likely to be assumed that all that is required in such a case is to test infected material and compare the results with standard average data for the

Variation in Density and Hardness of Synthetic Enamel Fillings

The individual specific fuse the temperature and temperature parallel to plastic basis are presented in Table I for the material indicated with [illegible] Combination#11 and in Table 2 for the material indicated with [illegible].

It will be noted that a rather unsatisfactory difference between the hardness values for old and even material specimen values, the all specimens melting eliminally higher. This difference is due primarily to the heating procedure and will be discussed later (see p. 30-32). In the former presentation of the data this difference has been eliminated by the reduction of hardness test values to a percentage basis.

Aside from the difference between old and even specimens, the data of Tables I and 2 exhibits a wide range in properties of individual specimens, both normal and inferred. The large variation in the weight and strength of wood, as above set only by Tables I and 2 but by all data on tests of wood, requires the careful attention the effect of fillings attach on instrument use. It is quite likely to be unwise base all that is required in wood a mass is by exact inferred material and

same species. Such a procedure would, however, be subject to great error, since variations of as much as 2 to 1 in specific gravity, or 4 to 1 in some mechanical properties occur not only within a species, but even in the same tree, and consequently, inherent differences in the quality of the material may entirely outweigh the effect of fungous action. In investigations of the effect of fungous action, therefore, great care is required to select material and group data in such a manner that infected wood will be compared only to such sound wood as can be assumed to have the same average properties as the infected wood possessed before the fungous attack. Analysis of a large amount of data indicates that no selection of material or grouping of data will render comparisons between individual specimens reliable, but that the danger of erroneous conclusions may be reduced to a minimum by averaging a number of specimens from the same annual growth layers and within a reasonable range in the height of the tree.

The variations with position in trees, as found in the present investigation, and the grouping of data to reduce the effect of these variations on comparisons are discussed below:

Tree V, infected with Polyporus Schweinitzii, was burned at the base when it was approximately 160

years old, and the fungus probably gained entrance at this wound. In healing, the tree produced abnormal wood in the vicinity of the wound for a number of years. This abnormal wood was not suitable for test, and only that portion of the tree produced prior to the wound was used for study. Practically all of this wood in bolt A-1 was infested (see Fig. 18, A), and no sound specimens could be obtained in this part of the tree. The specific gravity of the uninfected wood gradually increased from the pith region to the circumference of the portion tested, and hence, even at sections of moderate infection, the control and infected specimens would be poorly matched unless obtained from the same annual growth layers. A large number of sound specimens from above the limits of infection were, however, available and were used as controls. Details regarding the method of selecting the controls are given below:

As shown at A, Fig. 1, the specimens were laid out on different radii. The first specimen on each radius was cut from the same annual growth layer so far as this was possible, the remaining specimens on the same radii being adjacent to each other. The outermost or first specimen on each radius was numbered 1, the next specimen

numbered 2, etc. Hence all specimens of the same number were from approximately the same annual growth layers.

Values for all specimens with a given number in sub-bolts B-1, B-2, and B-3, from tree 9, which had been found to be free of infection, were averaged and the average was used as a control value for the infected specimens of the same numbers in sub-bolts A-1, A-2, A-3, and A-4. Thus, each value for an individual specimen in bolts A-1, A-2, A-3, and A-4 was compared to the average of all specimens at approximately the same distance from the guide ring, and hence from approximately the same annual growth layers, in bolts B-1, B-2, and B-3.

This scheme eliminates as far as practicable the factor of difference in quality due to variations in material produced at different stages of growth. Also, a study of the sound material available at different heights in the tree shows that while considerable variations[4] in strength exists, it is not consistent or systematic with respect to height in the tree. Consequently, no systematic error results from such comparisons as outlined above; and while comparisons of individual infected specimens to the proper group of control specimens are subject to considerable error, such errors are as likely to be positive as negative, and very largely compensate when averages are considered.

---

[4] It was found that the probable variations below the control values for individual uninfected specimens in bolts A-1, A-2, and A-3 were as follows: Specific gravity, 4 per cent; compression parallel to grain, 7 per cent; toughness, 12 per cent.

The two logs of tree 3, attacked by Trametes pini, were infected throughout their entire length, and hence the method of grouping specimens necessarily differed from that employed for tree 9. The infection was limited to one side of the tree. It was possible, therefore, to obtain control material from the other side. In this case, all the values for non-infected specimens from boards 16 to 42, inclusive (except in sub-bolts C-3 and D-1, where board 42 was not included) bearing a given number and falling within a certain sub-bolt, as for example C-1, were averaged together and this average used as a control for the other specimens of the same number within the same sub-bolt length. Thus, the controls for the infected specimens were obtained from the same annual growth layers and the same height in the tree.[5]

Reduction of Data to Percentage Basis

As previously mentioned, the specific gravity of the sound material in tree 9 increased rather rapidly from the pith outward with a corresponding increase in the strength values. It is evident then that two infected

---

[5] In bolts C-1, C-2, C-3, and D-1, a study was made of the variation of test results for uninfected specimens from the control values. The probable variations below the control values were found to be as follows: Specific gravity, 2 per cent; compression parallel to grain, 6 per cent; and toughness 12 per cent.

specimens might show the same strength values and yet have been affected in quite different degrees by the infection, or might show quite different strength values in spite of having suffered the same relative loss from infection. It is evident also that this obstacle to comparisons among infected specimens can be overcome by expressing the test value for each specimen as a percentage of the corresponding average value for the proper control group. Such procedure also has obvious advantages in comparing infected material with control material and in expressing the variations of individual sound specimens from the averages of the control group to which they belong. This principle of reduction to a percentage basis has been applied in the preparation of all diagrams except Figs. 1 and 19.

Previous tests on sound material under center loading had demonstrated that toughness test values of Sitka spruce are largely affected by the direction of the applied load with respect to the position of the annual growth layers, the highest values being obtained when the load is applied on the tangential or flat-sawn face. In order to determine whether the same relation holds for third-point loading, as used in this investigation, and also for infected material, half of the specimens were tested with the load applied on the radial or edge-grain face and the other half with the load

applied on the tangential face. Analysis of the data showed that the toughness values of specimens tested with the load applied on the radial face averaged approximately 0.7 those for specimens with load applied on tangential face. This approximate ratio held for both infected and non-infected material and for both fungi (see Tables 1 and 2). The ratio of 0.7 is approximately the same as that previously found for sound material under center loading. Since all odd-numbered specimens were tested with the load applied on the tangential face and even numbered specimens with the load applied on the radial face, the grouping for loading corresponds in all cases to the grouping for comparisons between sound and infected material. Consequently the difference resulting from the method of loading does not appear when the test values have been reduced to a percentage basis, and need not be further considered in analyzing the effect of fungous attack on the mechanical properties.

Discussion of Results

The Effect of Polyporus Schweinitzii on Certain Properties of Sitka Spruce

Toughness values for each specimen from tree 9, expressed in percentage, are shown graphically in Fig. 2



Figures 2 to 6

Figures 2 to 6 inclusvie present toughness test data. Each diagram represents a single sub-bolt approximately 20 inches long. The value for each specimen is expressed as a percentage of the corresponding average control value. Each small square represents the position of a single specimen. The black dot designates infection. Contour lines have been drawn on diagrams representing sub-bolts A-1 to A-4 in such a manner that the position of those specimens having percentage values within certain limits can be seen easily.

Figure 1 to 3

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES AND CONTOURS — PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-1	POLYPORUS SCHWEINITZII

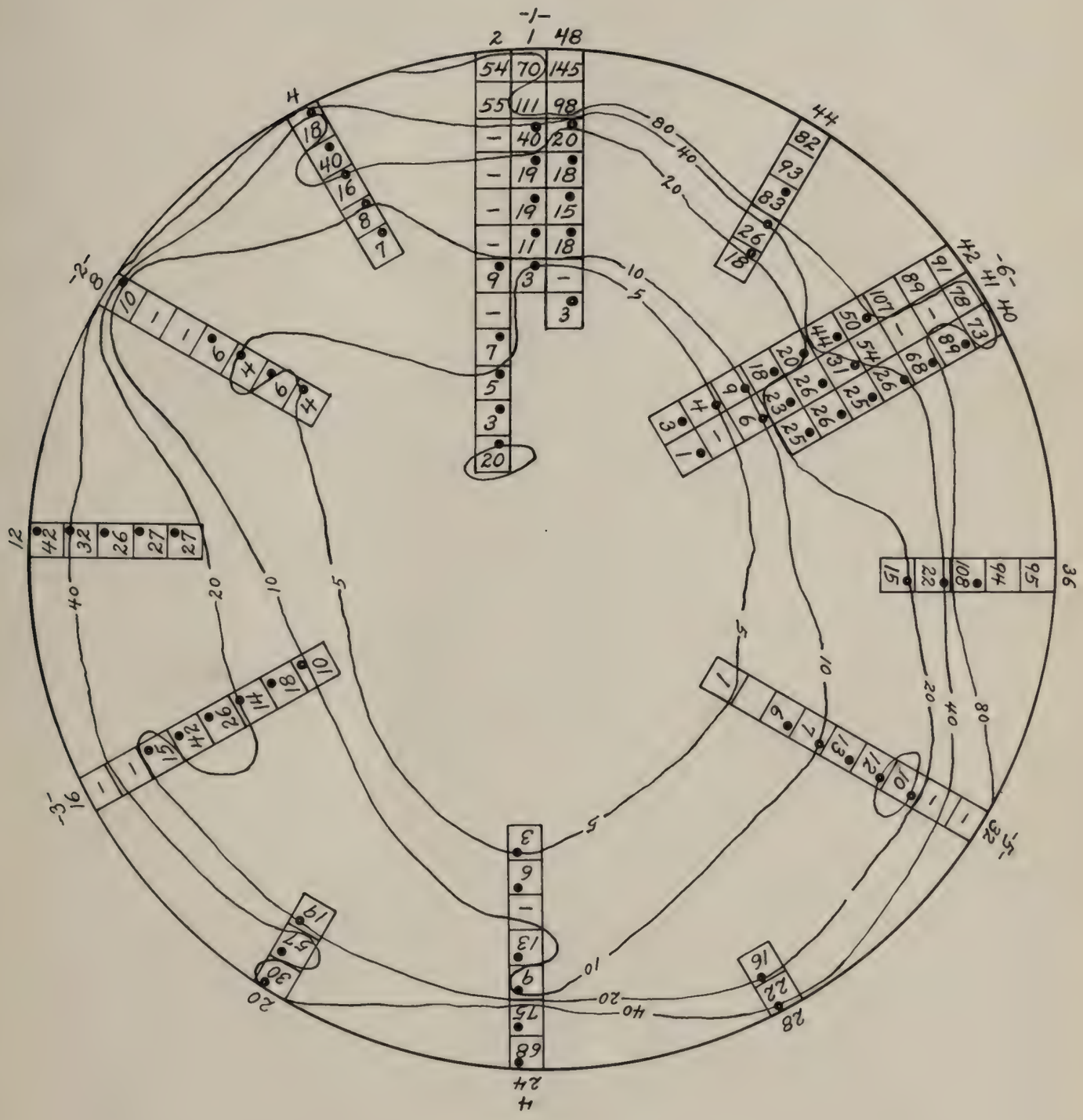


FIG.-2

LEGEND
● — INFECTED SPECIMEN

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R.A.H.
R.H.C.

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES AND CONTOURS — PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-2	POLYPORUS SCHWEINITZII

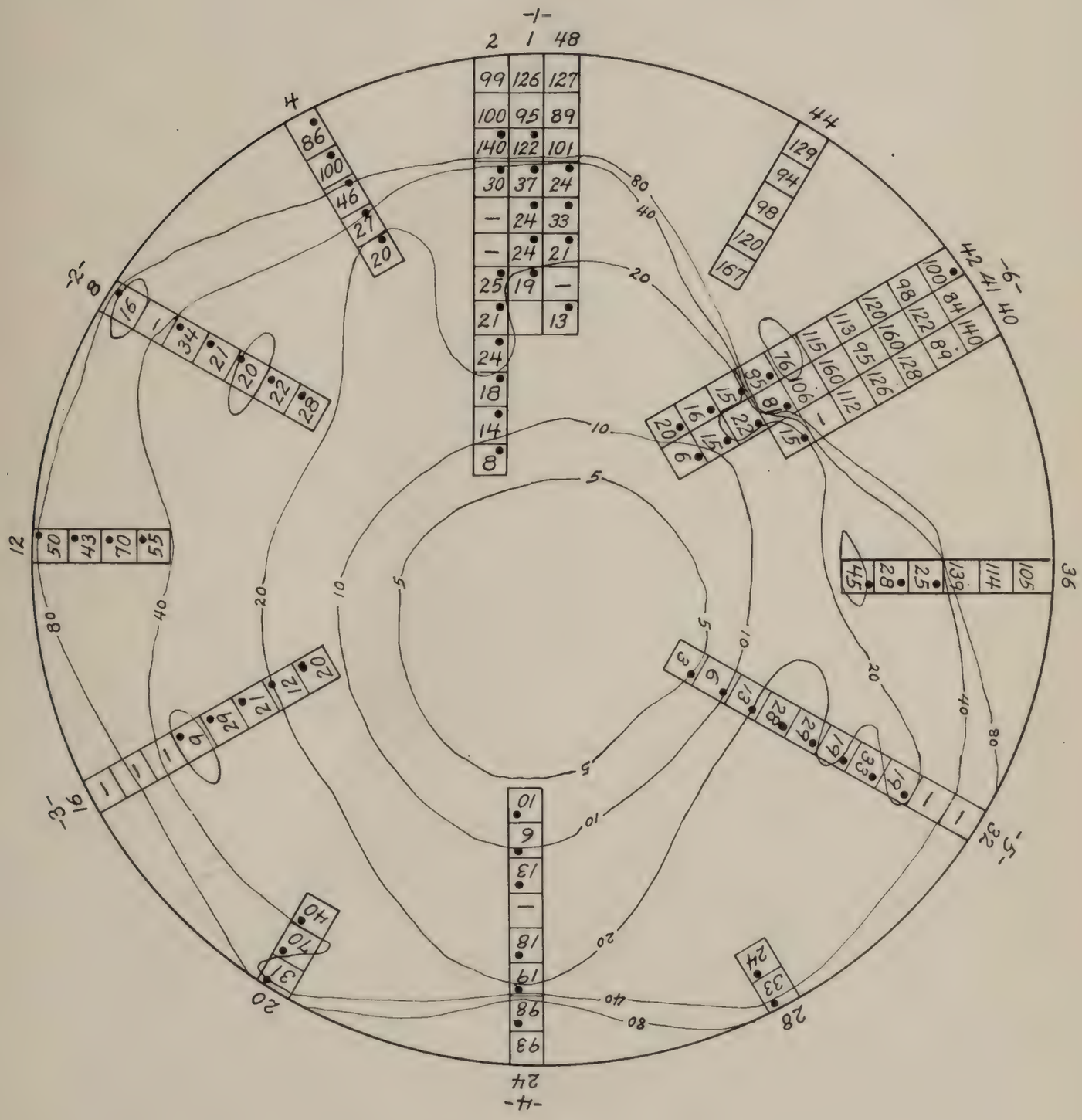


FIG.-3

LEGEND
• — INFECTED SPECIMEN

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SHIPMENT 987
TREE 9
PROJ. 243-J1

R.J.L.

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES AND CONTOURS — PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-3	POLYPORUS SCHWEINITZII

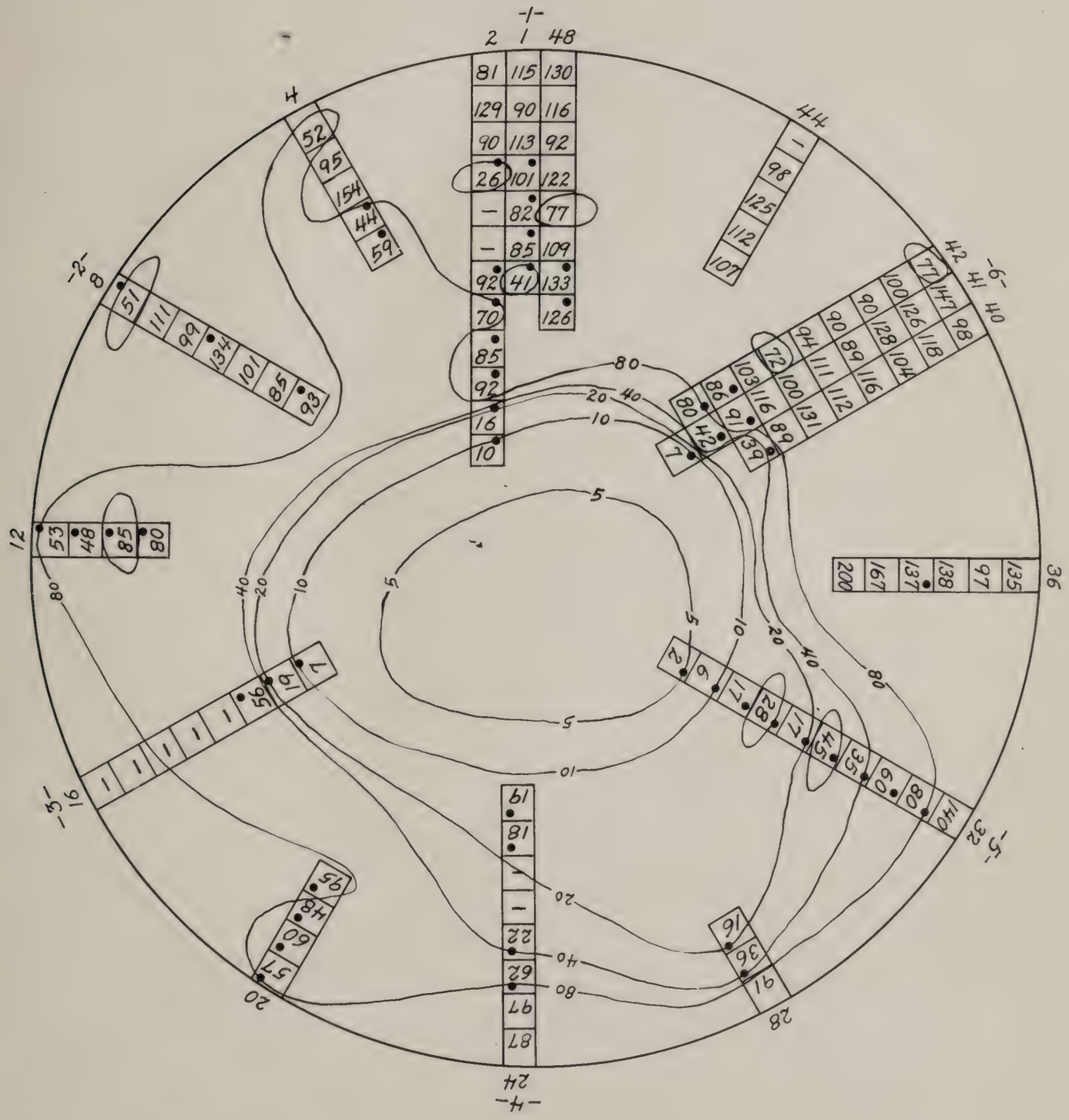


FIG.-4

LEGEND
• — INFECTED SPECIMEN

M962F

SHIPMENT 987
TREE 9
PROJ. 243-J1

R.F.L.
R.H.C.

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES AND CONTOURS — PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-4	POLYPORUS SCHWEINITZII

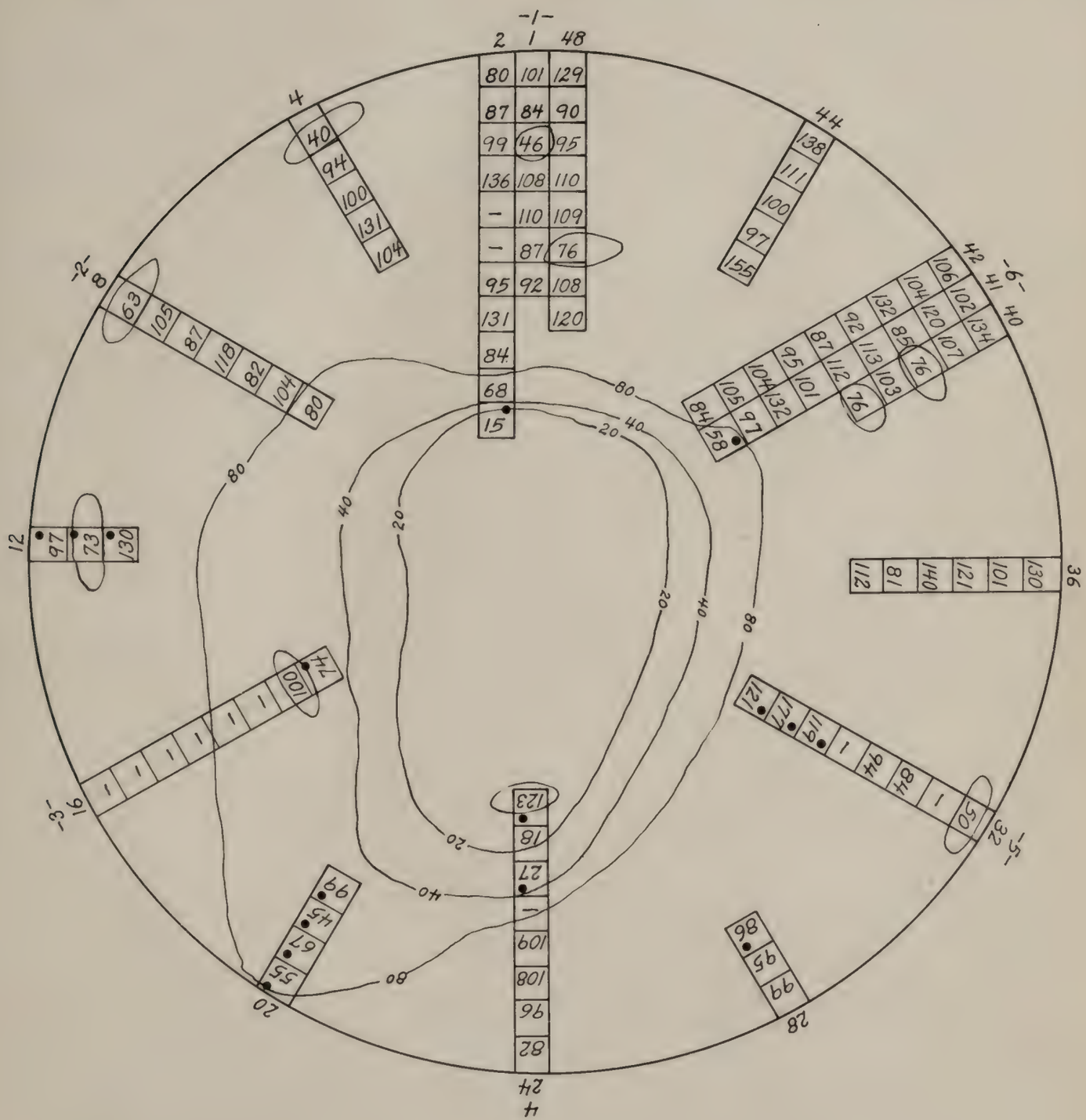


FIG.-5

LEGEND

● — INFECTED SPECIMEN

M963F

SHIPMENT 987
TREE 9
PROJ. 243-J1

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES — PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES: SITKA SPRUCE

BOLT: B-1

FUNGUS SPECIES: POLYPORUS SCHWEINITZII

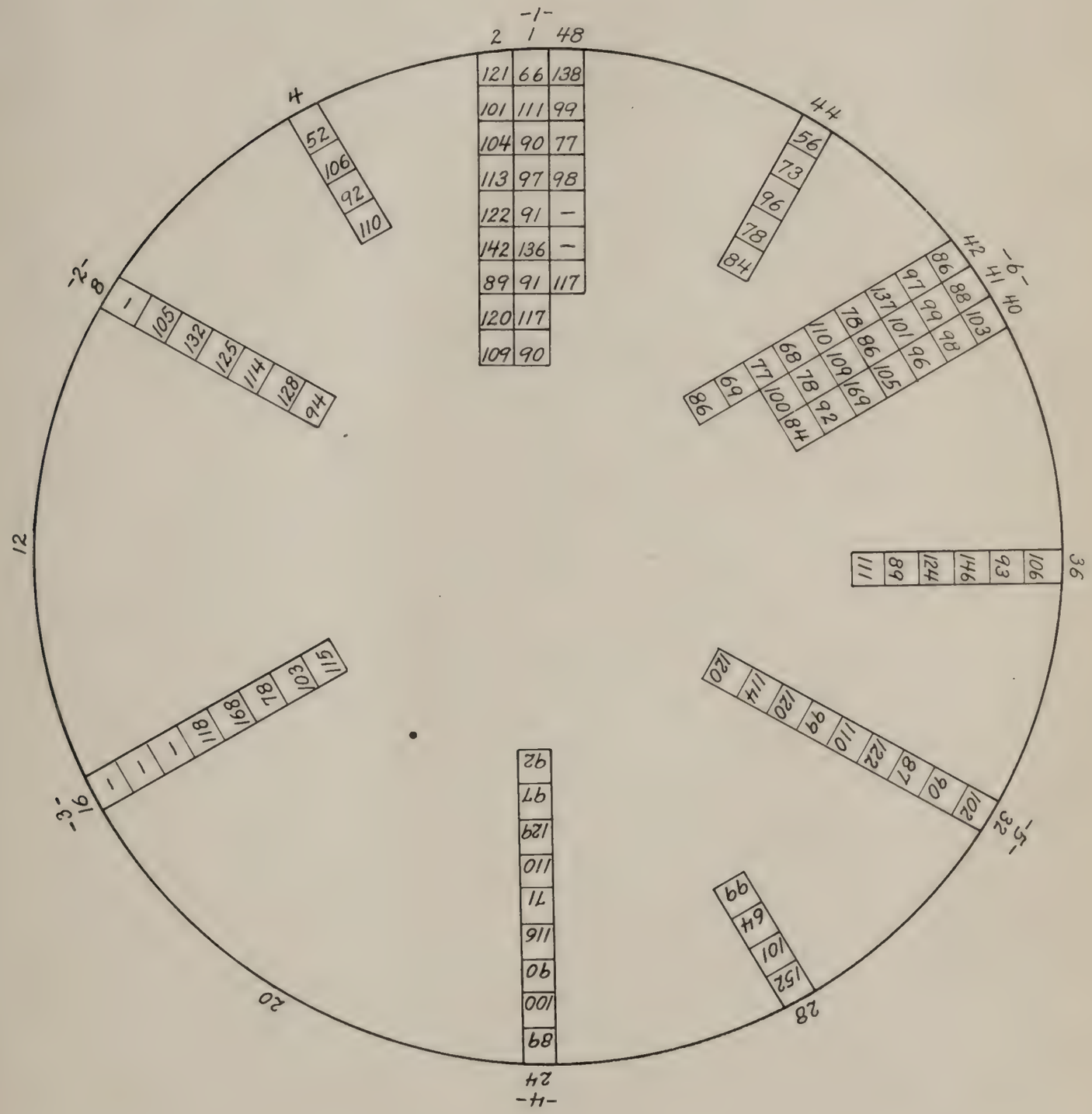


FIG.-6

SHIPMENT 987 R.J.h.
TREE 9
PROJ. 243-J1

M764F

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES—PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA	B-2	POLYPORUS SCHWEINITZII

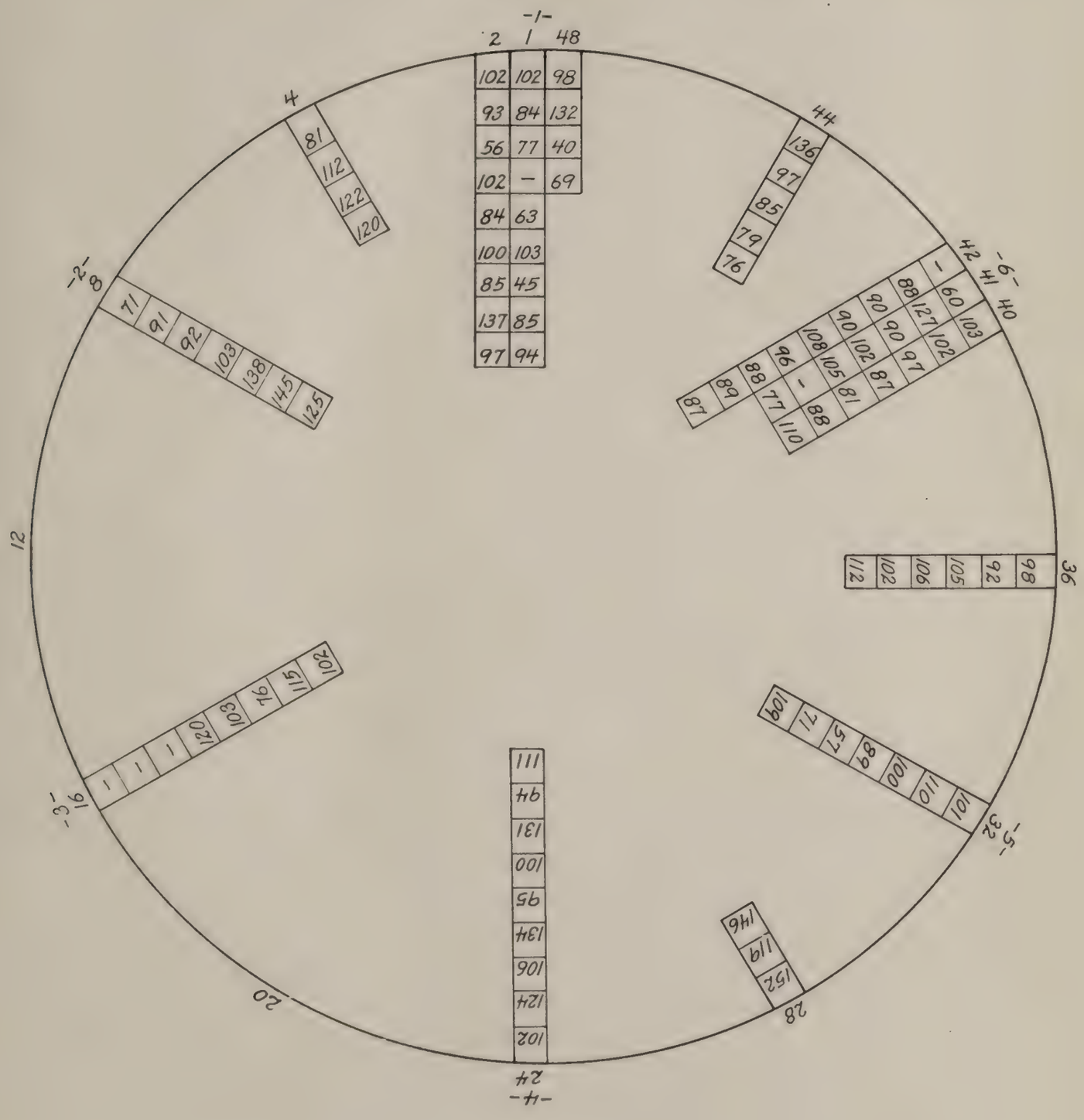


FIG.-7

SHIPMENT 987 R.J.L.
TREE 9
PROJ. 243-J1

M765F

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES—PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	B-3	POLYPORUS SCHWEINITZII

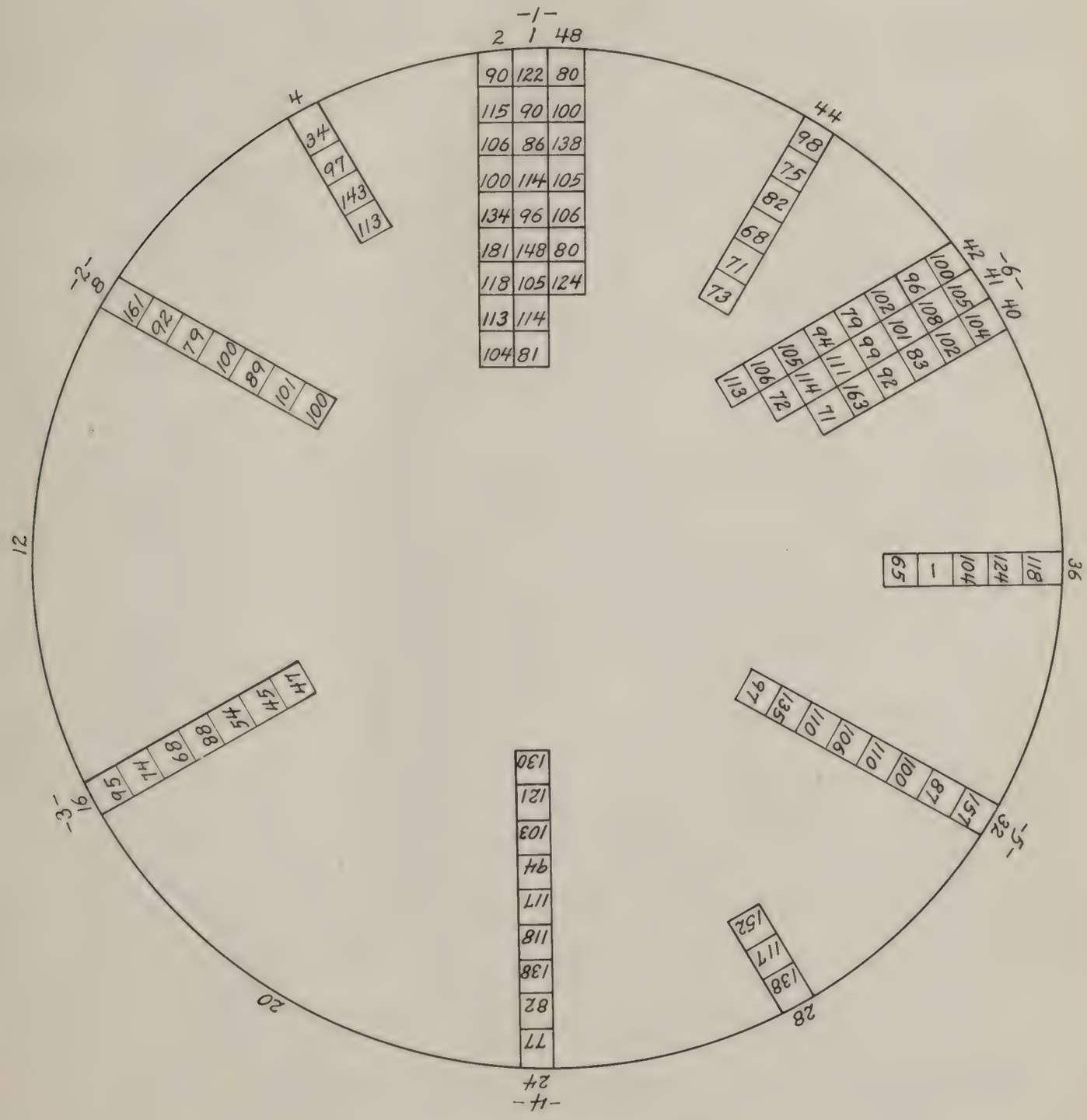


FIG.-8

SHIPMENT 987
TREE 9
PROJ. 243-J1

R.J.L.
CHC

M966F

to 3. In Figs. 2 to 5, representing the sub-bolts in which infection was found, contours have been drawn in such a way that the position of those specimens having percentage values within certain limits can be seen easily. In sub-bolt A-1 (Figs. 2 and 13), which is at the point where there was the most decay in the material studied, a considerable area of the cross section lies within the contour including material having values only 5 per cent of the normal. Cross sections representing sub-bolt A-2 and A-3 (Figs. 3 and 4) also show a 5 per cent contour line, but it bounds a considerably smaller area. Sub-bolt A-4 (Fig. 5) is near the limit of infection and no 5 per cent contour appears, the lowest values being about 20 per cent of those for normal material.

The several cross-sectional diagrams as well as the diagram of longitudinal sections (Fig. 14, B to E) show a very close agreement between the limit of infection and the 80 per cent contour lines. Apparently a reduction of at least 20 per cent in shock-resistance can be expected in Sitka spruce in which infection with Polyporus Schweinitzii has progressed to the point where it can be detected by microscope or culture.

The reduction in compression parallel to grain values shown in Figs. 9 to 13 is much less than the reduction in toughness. While the contours are based on



Figures 9 to 15

Figures 9 to 15 inclusive present compression parallel to grain data. Each diagram represents a single sub-bolt approximately 20 inches long. The value for each specimen is expressed as a percentage of the corresponding average control value. Each small square represents the position of a single specimen. The black dot designates infection. Contour lines have been drawn on diagrams representing sub-bolts A-1 to A-4 in such a manner that the position of those specimens having percentage values within certain limits can be seen easily.

Figure 1 to 33

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES AND CONTOURS PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-1	POLYPORUS SCHWEINITZII

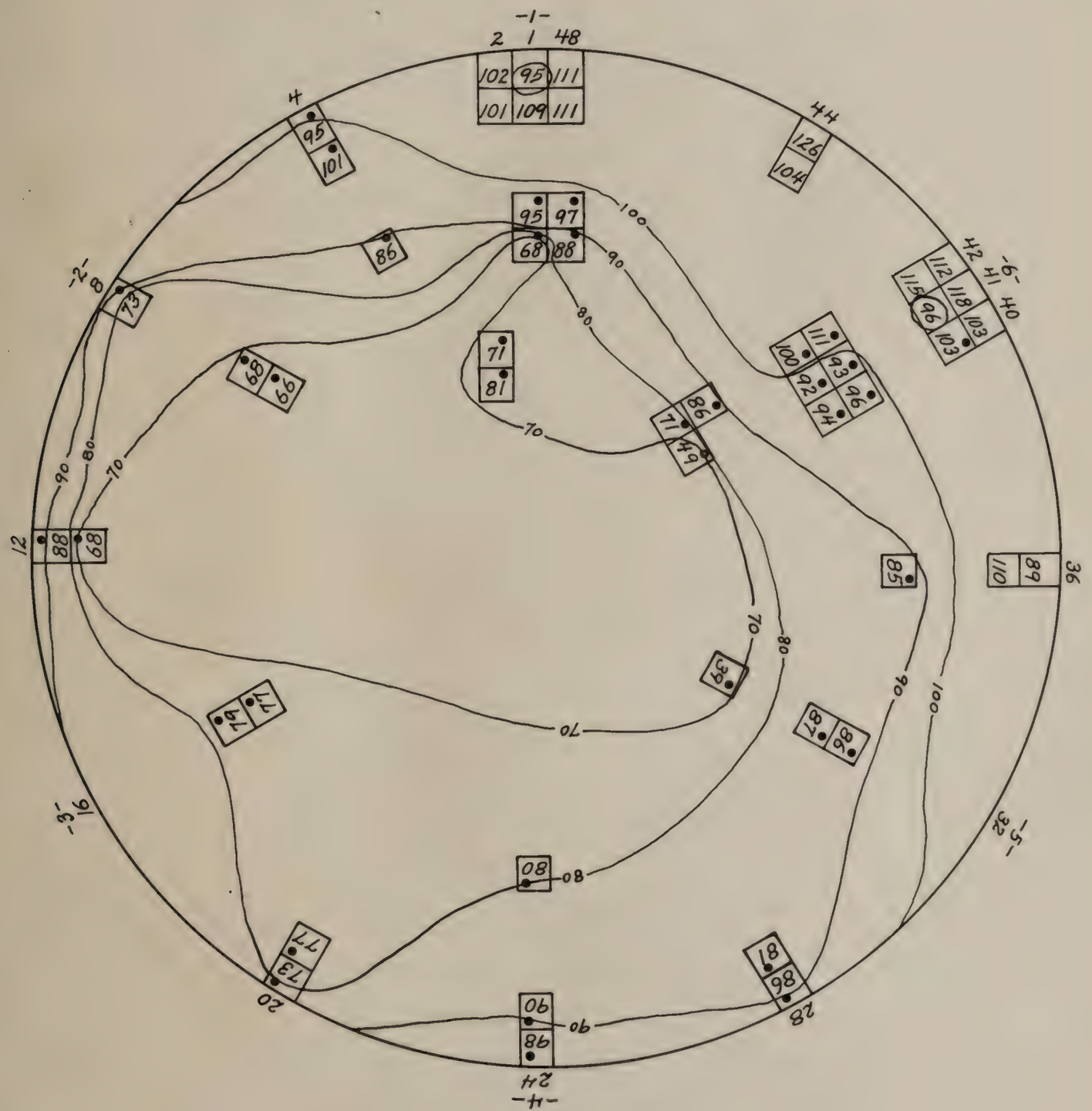


FIG.-9

LEGEND
● — INFECTED SPECIMEN

M967F

SHIPMENT 987
TREE 9
PROJ. 243-J1

R.F.L.

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES AND CONTOURS
PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-2	POLYPORUS SCHWEINITZII



FIG.-10

LEGEND
● — INFECTED SPECIMEN

M4581

SHIPMENT 987
TREE 9
PROJ. 243-J1

R.H.

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES AND CONTOURS PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-3	POLYPORUS SCHWEINITZII

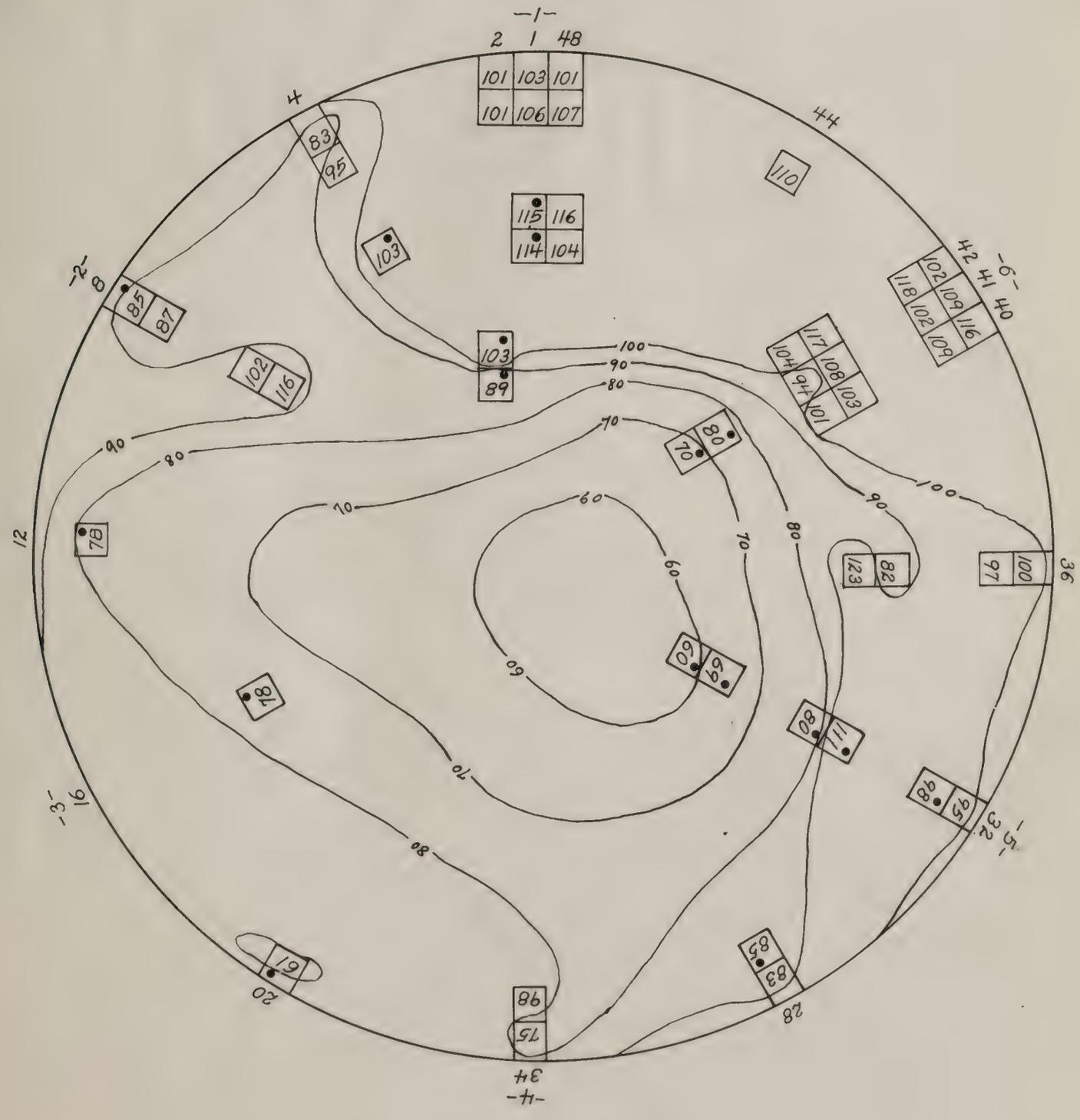


FIG.-11

LEGEND
• - INFECTED SPECIMEN

M9698

SHIPMENT 987
TREE 9
PROJ. 243-J1

R.J.h.
R.H.C.

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES AND CONTOURS PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-4	POLYPORUS SCHWEINITZII

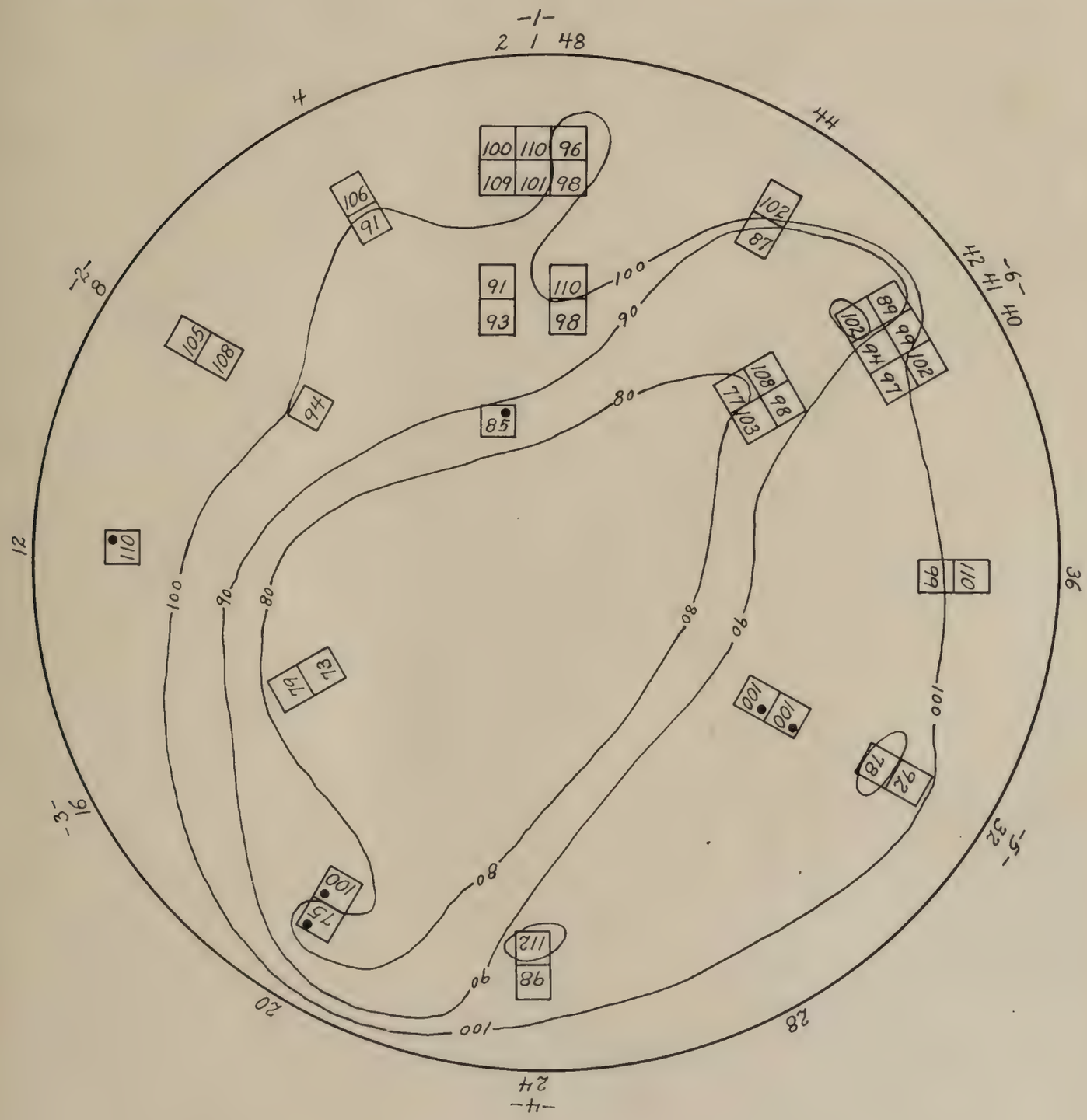


FIG.-12

LEGEND
• — INFECTED SPECIMEN

SHIPMENT 987
TREE 9
PROJ. 243-J1

R.F.L.
R.H.C.

M9705

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	B-1	POLYPORUS SCHWEINITZII

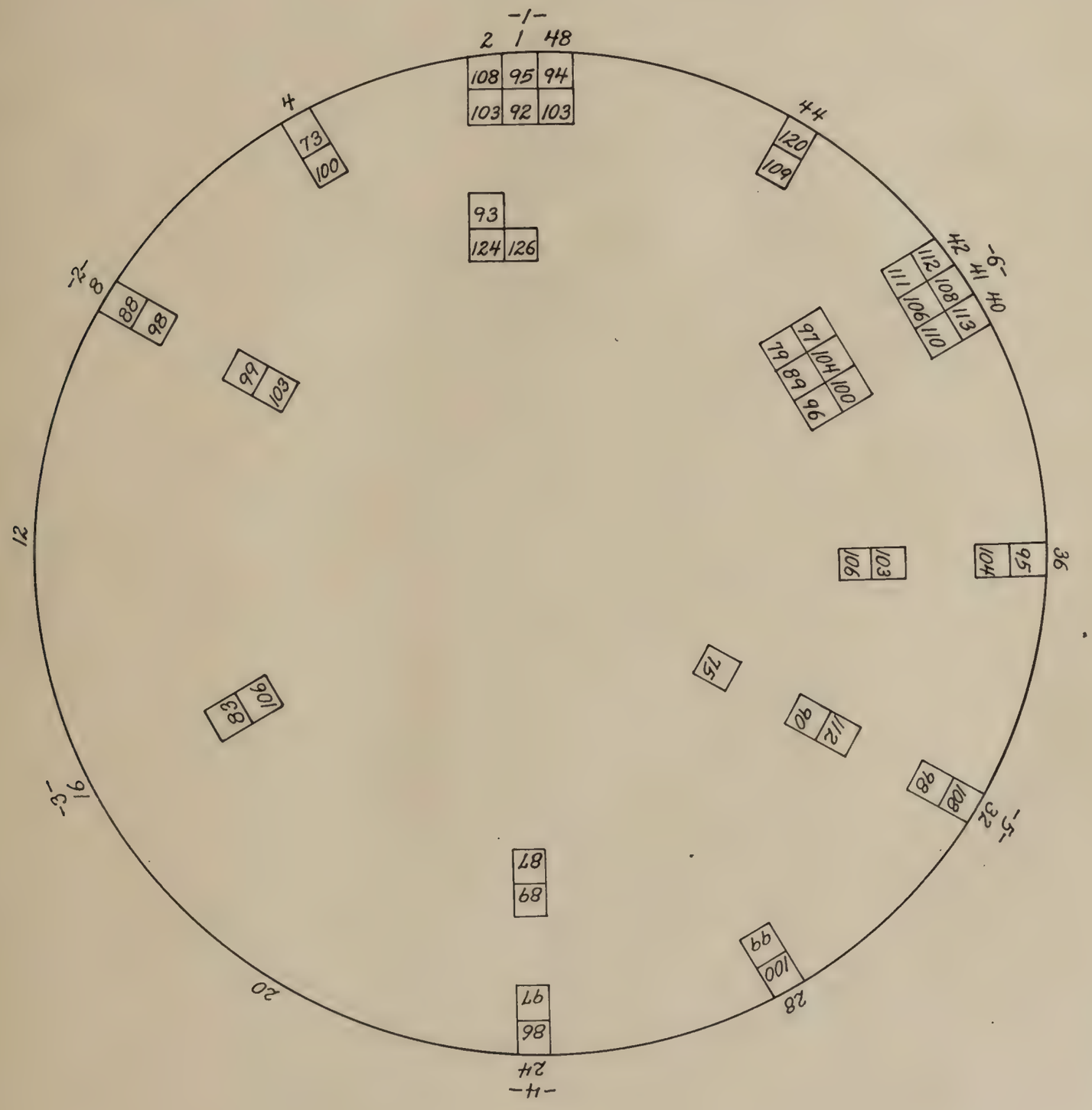


FIG.-13

SHIPMENT 987
TREE 9
PROJ. 243-J1

R.H.
R.H.C.

M971F

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES.
SITKA SPRUCE	B-2	POLYPORUS SCHWEINITZII

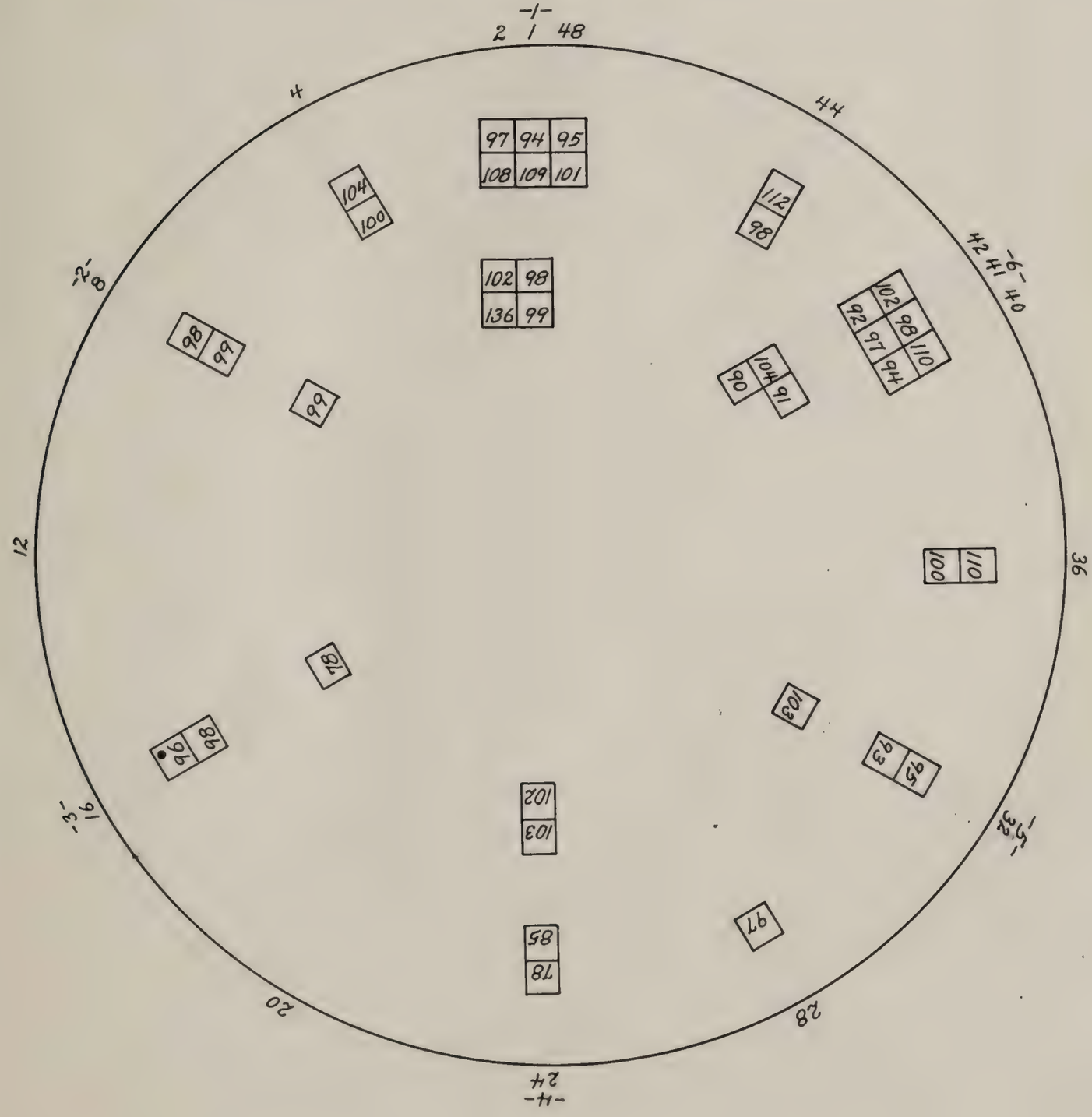


FIG.-14

SHIPMENT 987
TREE 9
PROJ. 243-J1

M9725

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	B-3	POLYPORUS SCHWEINITZII

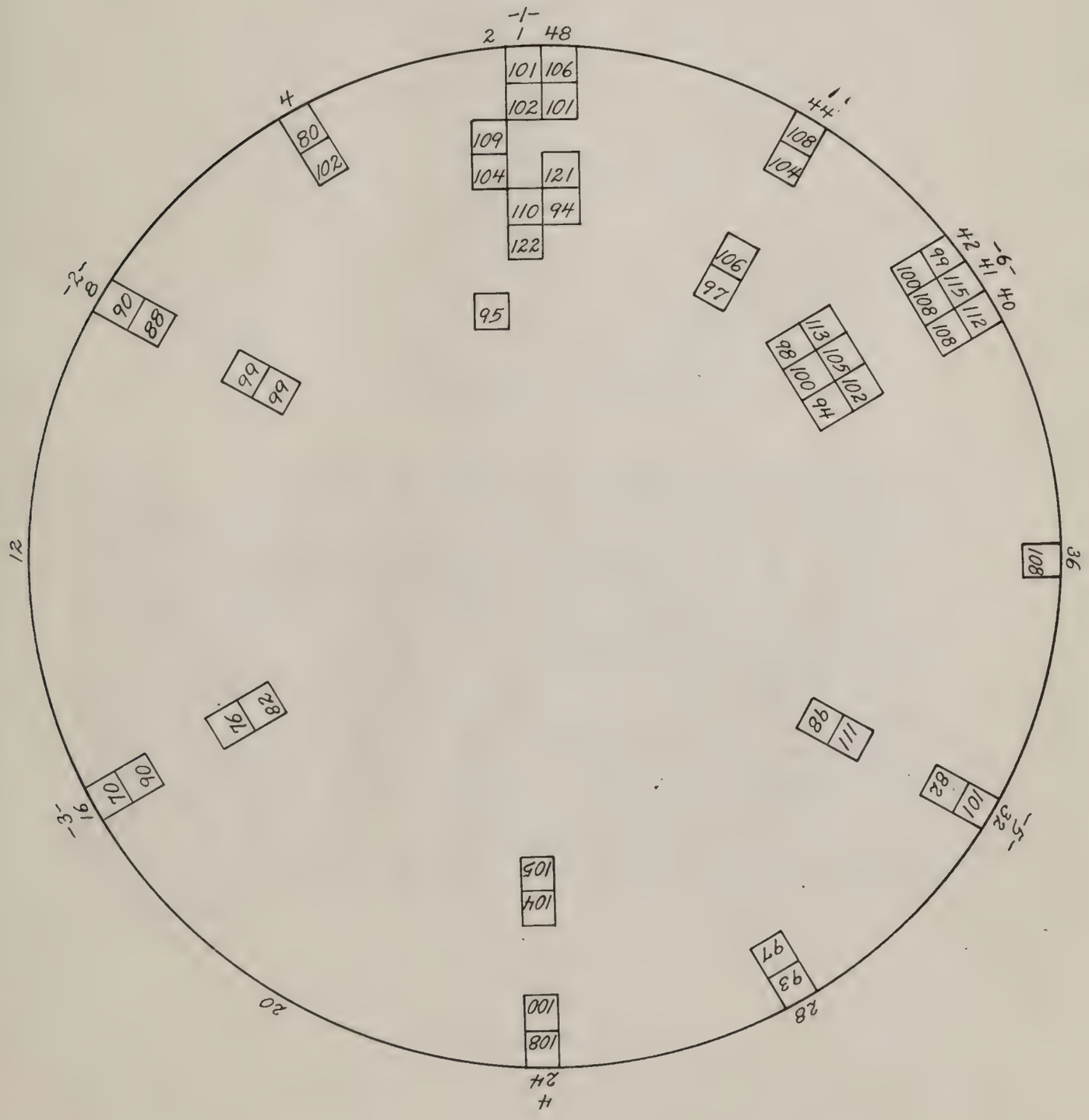


FIG.-15

SHIPMENT 987 R.P.L.
TREE 9 R.H.C.
PROJ. 243-J1

M973F

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING SPECIFIC GRAVITY VALUES AND CONTOURS—PERCENTAGE BASIS (VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES: SITKA SPRUCE | BOLT: A-1 | FUNGUS SPECIES: POLYPORUS SCHWEINITZII



LEGEND
• — INFECTED SPECIMEN

SHIPMENT 987
TREE 9
PROJ. 249-J1

Figures 16 and 17

Figures 16 and 17 present specific gravity data. Each diagram represents a single sub-bolt approximately 20 inches long. The value for each specimen is expressed as a percentage of the corresponding average control value. Each small square represents the position of a single specimen. The black dot designates infection. Contour lines have been drawn in such a manner that the position of those specimens having percentage values within certain limits can be seen easily. These diagrams represent the region of greatest infection and show that there was a relatively small change in specific gravity due to infection in the material studied.

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING SPECIFIC GRAVITY VALUES AND CONTOURS — PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-1	POLYPORUS SCHWEINITZII

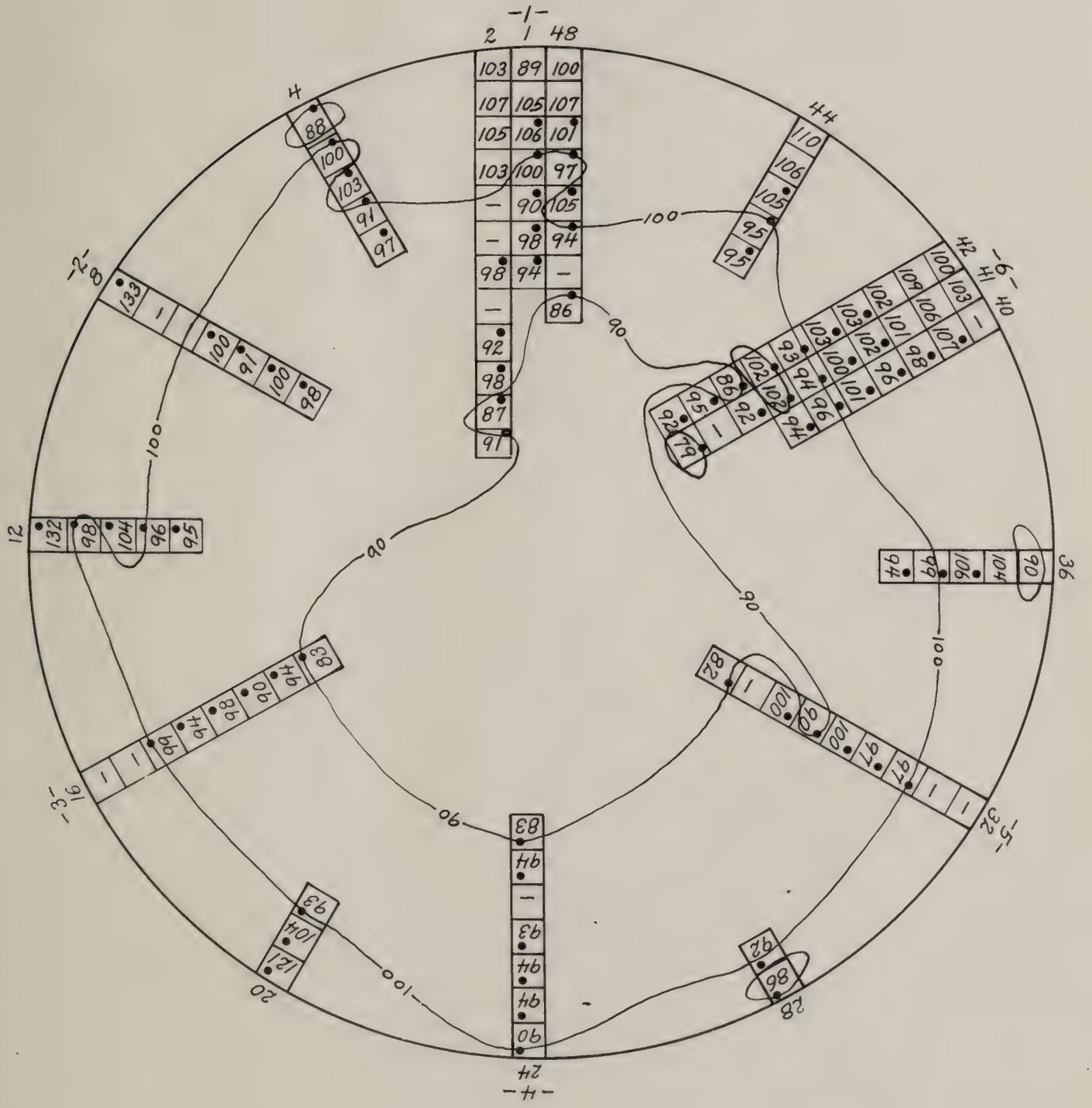


FIG.-16

LEGEND
• — INFECTED SPECIMEN
M9744

SHIPMENT 987
TREE 9
PROJ. 243-J1

CROSS SECTION SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING SPECIFIC GRAVITY VALUES AND CONTOURS — PERCENTAGE BASIS

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLT	FUNGUS SPECIES
SITKA SPRUCE	A-2	POLYPORUS SCHWEINITZII

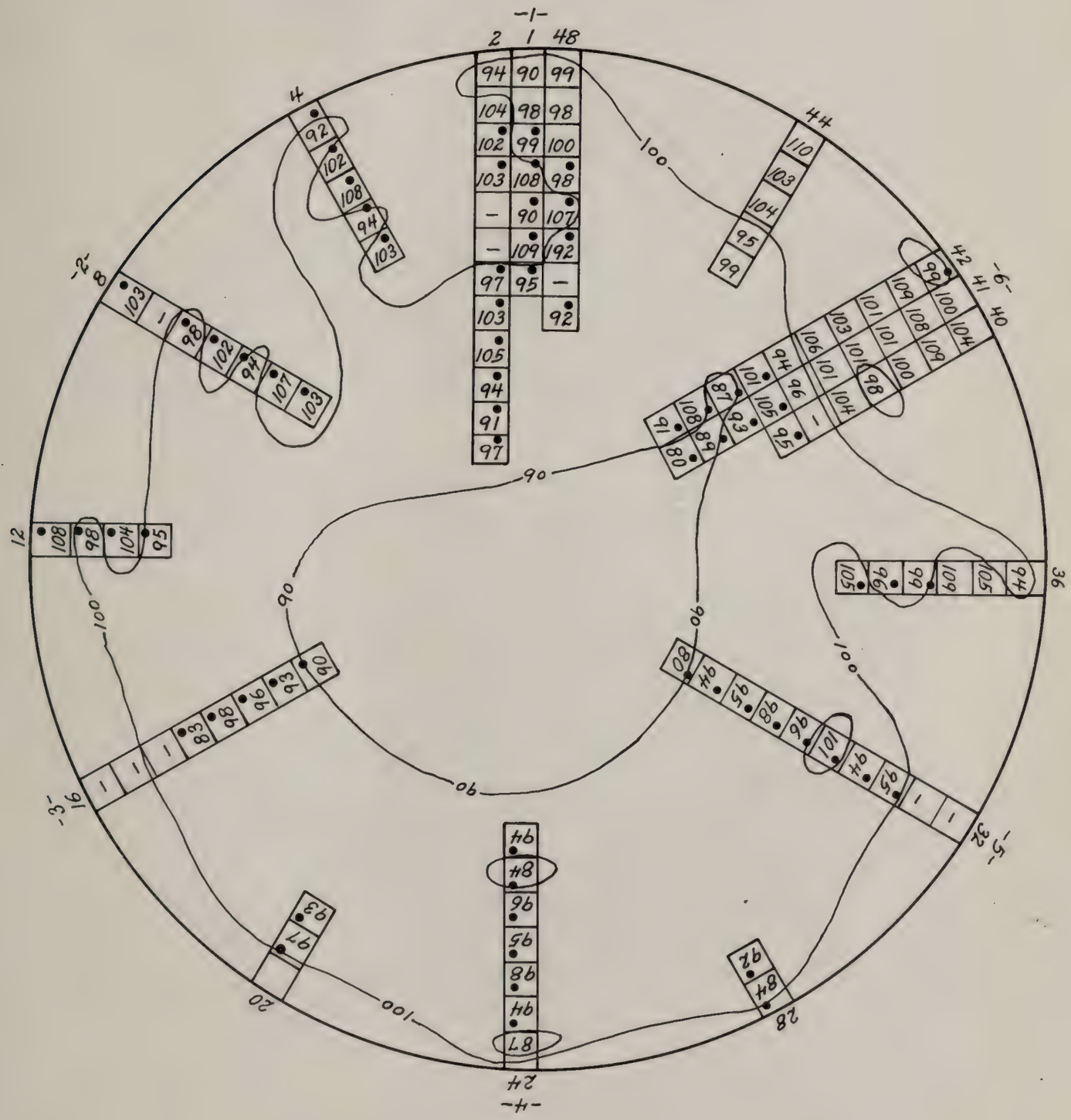


FIG.-17

LEGEND
● — INFECTED SPECIMEN

M975 F

SHIPMENT 987
TREE 9
PROJ. 243-J1

R.J.h.
R.H.C.

Figure 18

A is a sketch of tree 9 representing a longitudinal plane designated 12-36. The region of infection is indicated by shading. The part of tree tested is shown by a-b, c-d and connecting vertical dotted lines. The relative position of the several sub-belts is also shown.

B represents a cross-section at a-b and shows the position of the several longitudinal planes.

C, D, E and F are longitudinal section diagrams through the infected region of the part of tree tested. These diagrams were constructed from the cross-sectional diagrams figures 2-5. The several contour lines represent the remaining toughness strength of partially decayed wood expressed in percentage of control values. The heavy solid line indicates the limit of infection. The upper limit of each contour line and also of the line defining infection limit could not be drawn accurately due to lack of data, and they have therefore been dotted. The vertical dotted lines represent radial limits of material tested.

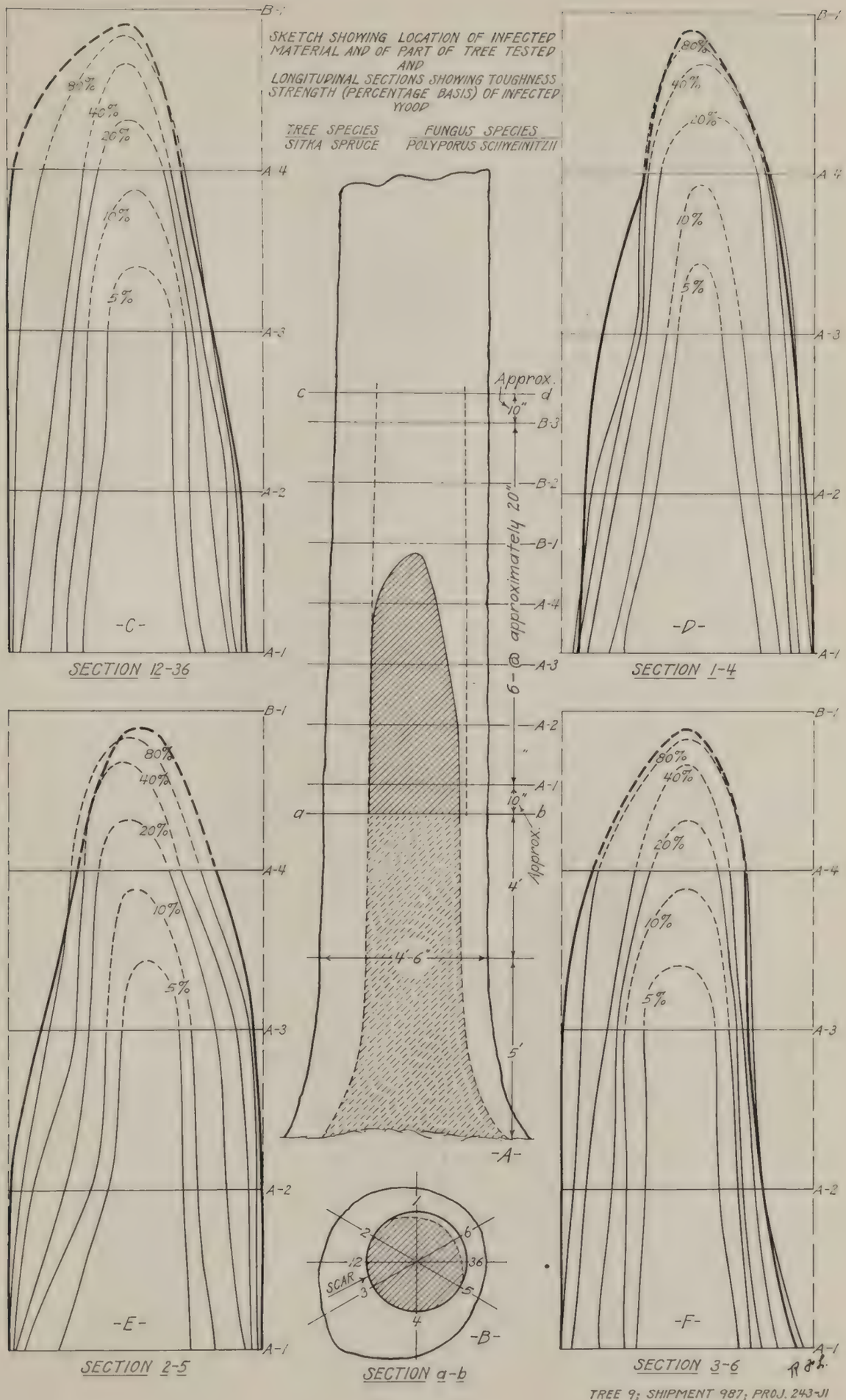


Figure-18

M 1139 F

Figure 19

A is a sketch of the tree representing a longitudinal plane designated 12-36. The region of infection is indicated by shading. The part of the tree tested is shown by a-b, c-d, and connecting vertical dotted lines. The relative position of the several sub-bolts is also shown.

B represents a cross section at a-b and shows the position of the several longitudinal planes.

C, D, E, and F are longitudinal section diagrams through the part of tree tested. These diagrams are based on cross sectional diagrams similar to those of Figs. 2-5 except that actual specific gravity values were used in place of percentage values. The cross sectional diagrams from which these longitudinal diagrams were constructed are not included in the report.

The several contour lines show the increase in specific gravity from near the center of the tree to the outer edge of the material tested. The heavy solid line indicates the limit of infection. The upper part of this line could not be accurately located due to lack of data and it was therefore dotted.

While there is a decided increase in the specific gravity from the center outward, it will be noted that this is true of uninfected as well as infected material. The only noticeable influence of decay on specific gravity is at section A-1.

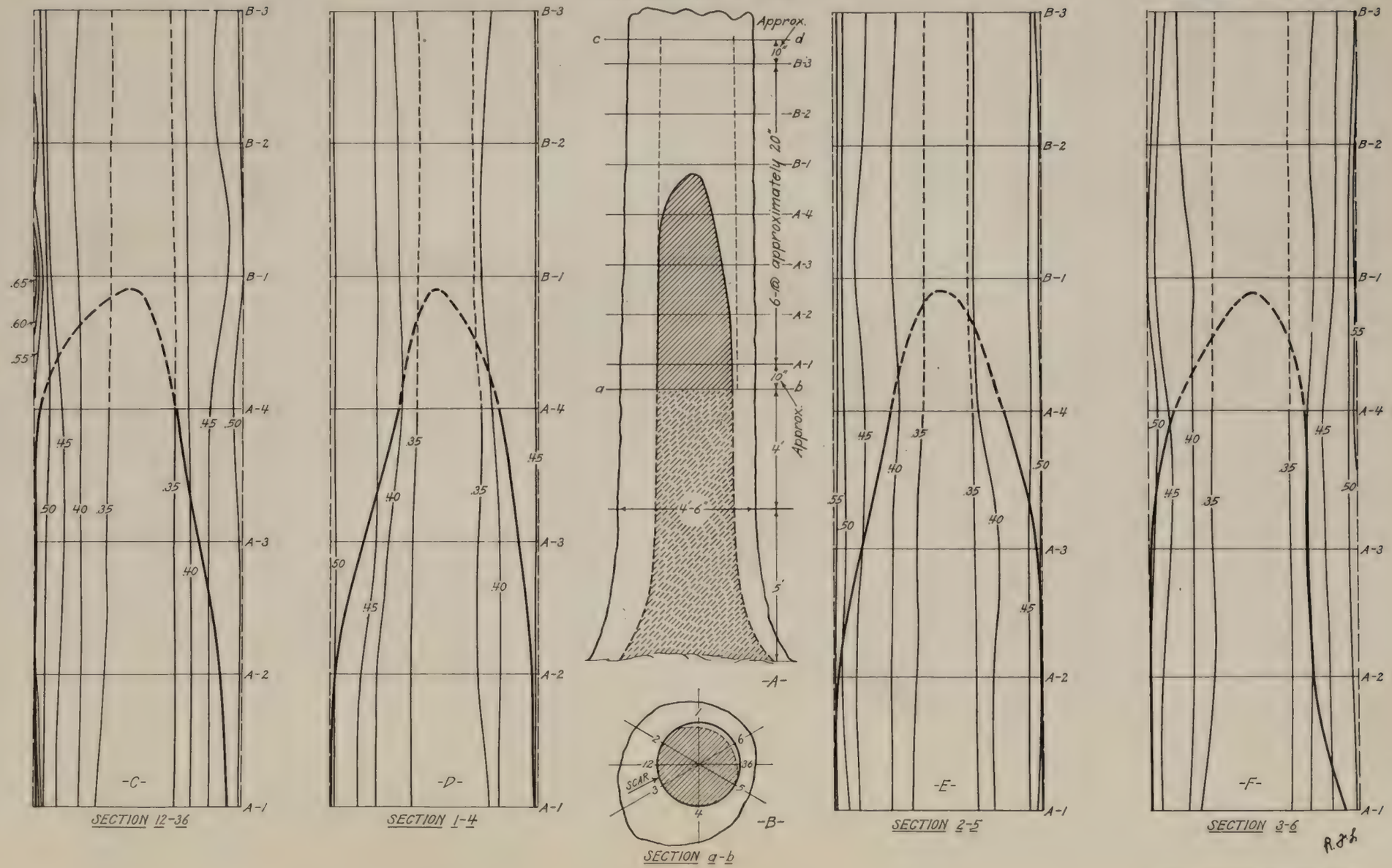
Serial Path.-1

Influence of

SKETCH SHOWING LOCATION OF INFECTED MATERIAL AND OF PART OF TREE TESTED
AND
LONGITUDINAL SECTIONS SHOWING VARIATIONS IN SPECIFIC GRAVITY IN BOTH INFECTED AND UNINFECTED WOOD

TREE SPECIES
SITKA SPRUCE

FUNGUS SPECIES
POLYPORUS SCHWEINITZII



SECTION 12-36

SECTION 1-4

SECTION a-b

SECTION 2-5

SECTION 3-6

Figure-19

M 1140 F

TREE 9; SHIPMENT 987; PROJ. 243-J1

fewer tests and are therefore not as accurately placed as the toughness contours, nevertheless a striking difference between these two properties with respect to the amount of decrease due to the fungous attack is indicated. Although in exceptional cases a reduction to 30 or 40 per cent of the original compression value is found, most of the lower values are included between the 60 and 70 per cent contour lines. It will also be noted that the coincidence of the dividing line between the infected and non-infected specimens with a particular percentage contour is not as marked as with the toughness values.

The material at the point where decay had progressed the farthest had a specific gravity of approximately 30 per cent of its original value, as shown by Figs. 16 and 17, while specimens from the same region retained only 5 per cent of their original toughness strength. It is doubtful whether anyone, if confined solely to a study of the specific gravity data (see Fig. 19), in the light of available information on the normal variations of specific gravity, would suspect the presence of decay in this tree; and furthermore, if one knew that the tree was infected, it would be utterly impossible to determine the limits of the infected region from a study of the gravity data alone.

The Effect of Trametes pini on Certain Properties of Sitka Spruce

Wood is attacked by Trametes pini in a much less uniform manner than by Polyporus Schweinitzii. Between the white pockets there are regions of very good wood (see Plate IV). As a result there are much larger variations in individual test values within a limited region than is true of wood infected with Polyporus Schweinitzii, and the method of contouring the test results as used for tree 9 could not be applied for tree 3. Data from this tree are shown in Figs. 20 to 31, inclusive, by means of cross-sectional and polar coordinate diagrams. The plotted points in the polar coordinate diagrams are average percentage values representing the boards of one sub-belt approximately 24 inches long. Points marked by white circles (connected by a solid line) represent values for sound material, generally located on the uninfected side of the tree. Points marked by black circles (connected by dotted line) represent values for decayed material. When uninfected and infected material were included in the same board, average values were obtained separately and plotted on the same radius. This, of course, means a reduction in the number of individual values included in such averages and makes the variation from normal in some places appear large.

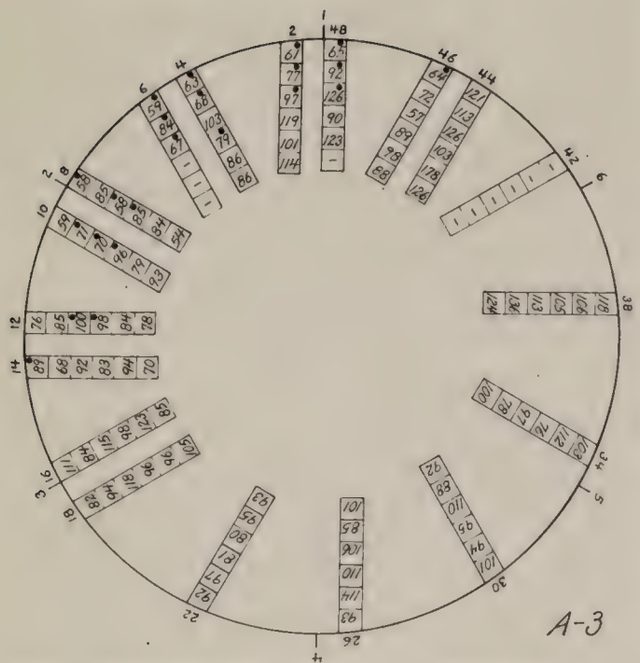
The Effect of Immediate Exit on Cognitive Dissonance as
Given Reading

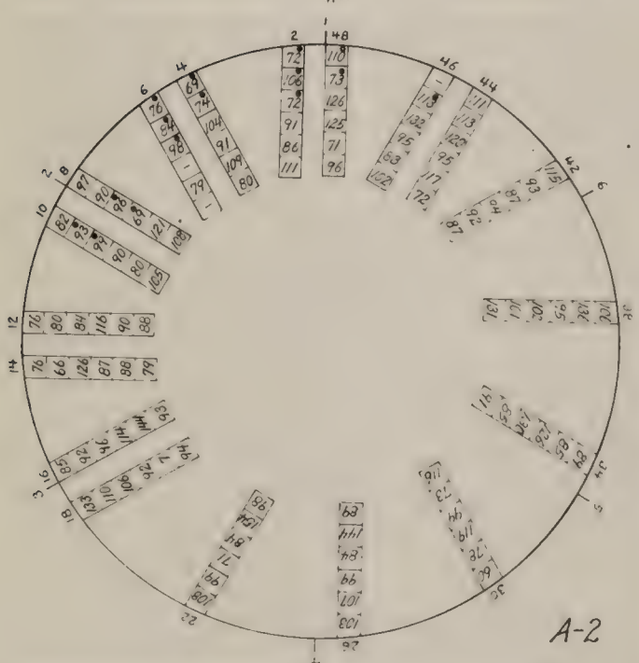
Mood is assessed by Experience Fifty (5) = Mean (Mood
Variance measure given by Experience Fifty-Eight. Variance
the middle possible choice one indicates no mood (see
Table IV). As a result there was much higher variance
in participants' mood ratings in Fifty-Eight (Experience
Time of mood is Low) as Experience Fifty-Eight, and
the majority of participants' mood ratings do not fall
a middle mood by ratings are three 3. Mean mood in
also slower in Mood of 58, Participants' by change of
Experience and Table Experience Fifty-Eight.
Participants in the Fifty-Eight Experience were assigned
randomly either Experience Fifty-Eight or Experience
Approximately 50 Fifty-Eight Each. Prior receipt of Table
Reading Material, Experience Fifty-Eight or Fifty-Eight
of the Time. Fifty-Eight Fifty-Eight Experience
by Fifty-Eight Time) Experience Fifty-Eight Variance
Time Experience and Experience Fifty-Eight Fifty-Eight
the Time Mood, Experience Fifty-Eight Experience
and Fifty-Eight in the Fifty Mood. Fifty, of Experience,
Mood in the Mood of Fifty-Eight Experience
Mood Experience of Time Experience Fifty-Eight
Time Fifty-Eight.

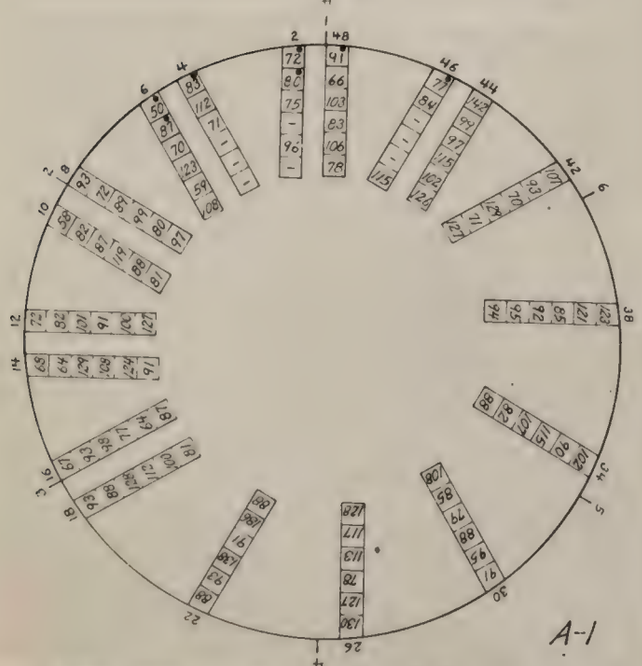
Figures 20 to 25

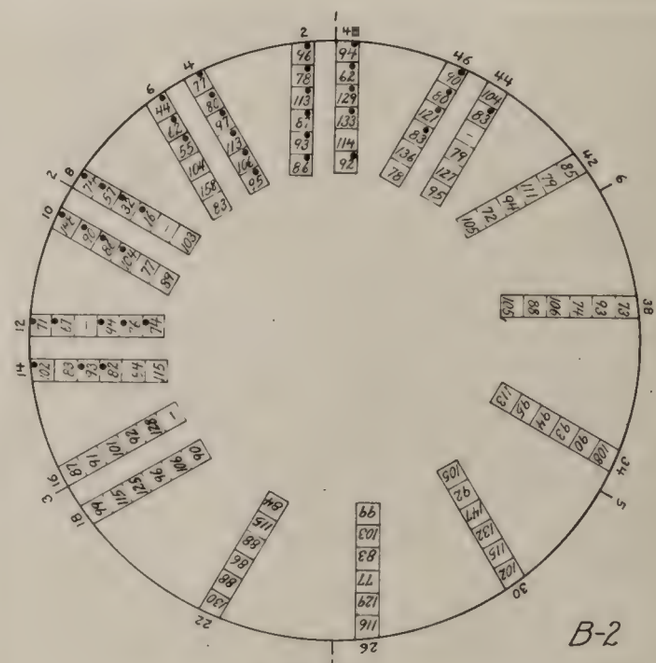
Figures 20 and 21 present toughness test data. Each diagram represents a single sub-bolt approximately 24 inches long. The value for each specimen is expressed in percentage of corresponding average control value. Each small square represents the position of a single specimen. The black dot designates infection.

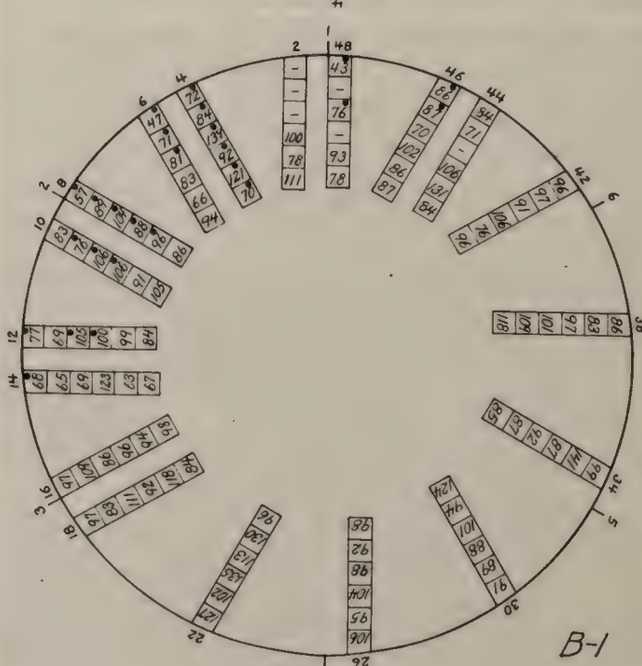
Similarly figures 22 and 23 present data on maximum crushing strength in compression parallel to grain, and figures 24 and 25 data on specific gravity.











CROSS SECTIONS SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES -PERCENTAGE BASIS-

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

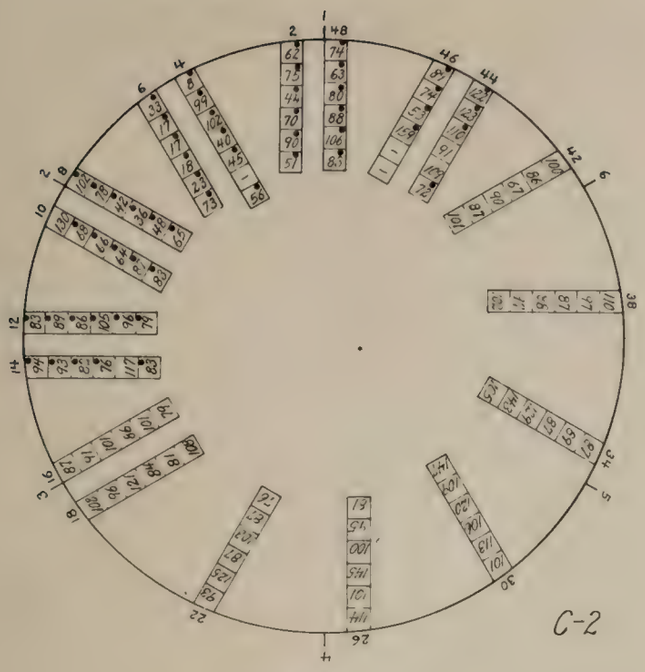
TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	A-1, A-2, A-3, B-1, B-2	TRAMETES PINI

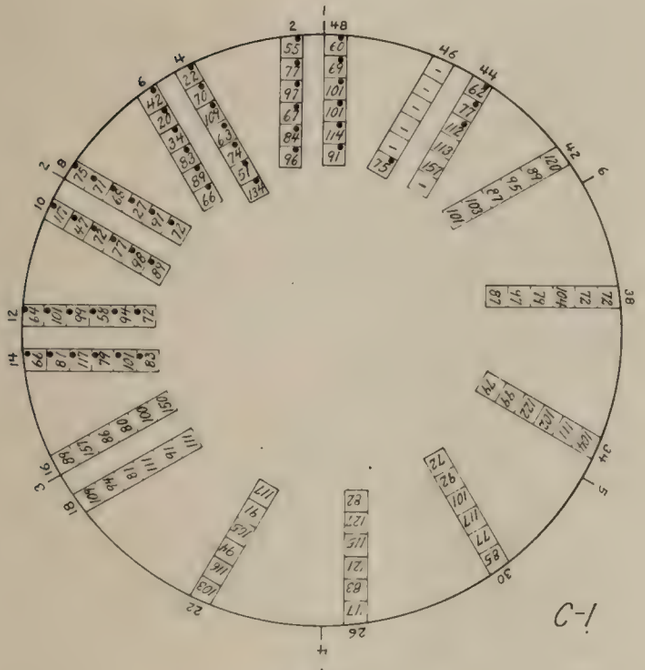
LEGEND
● = INFECTED

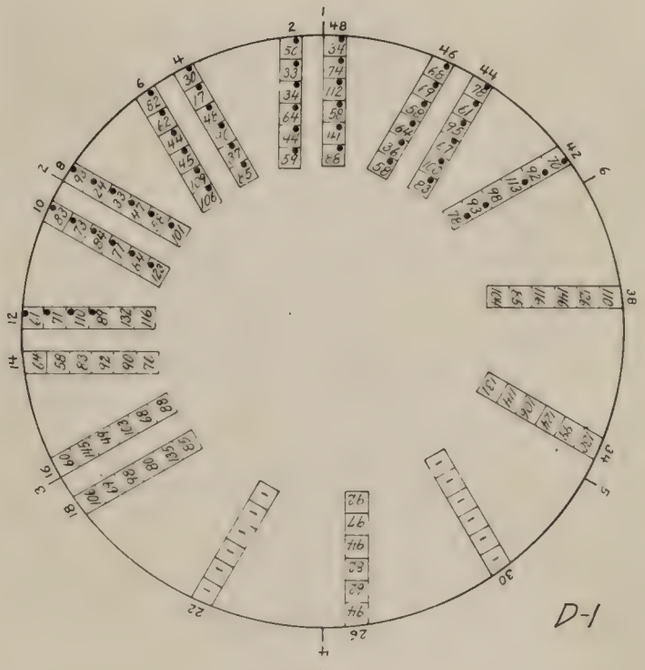
SHIPMENT 987 R81
TREE 3
PROJ. 243-J1

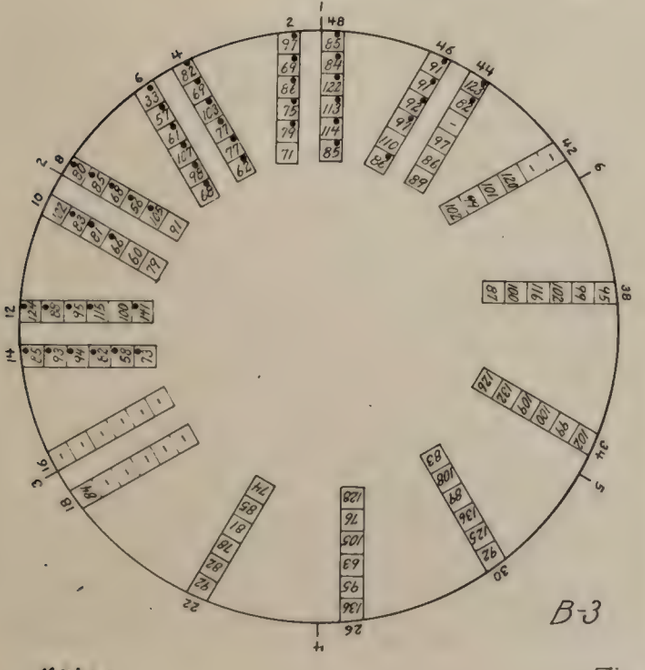
M11417

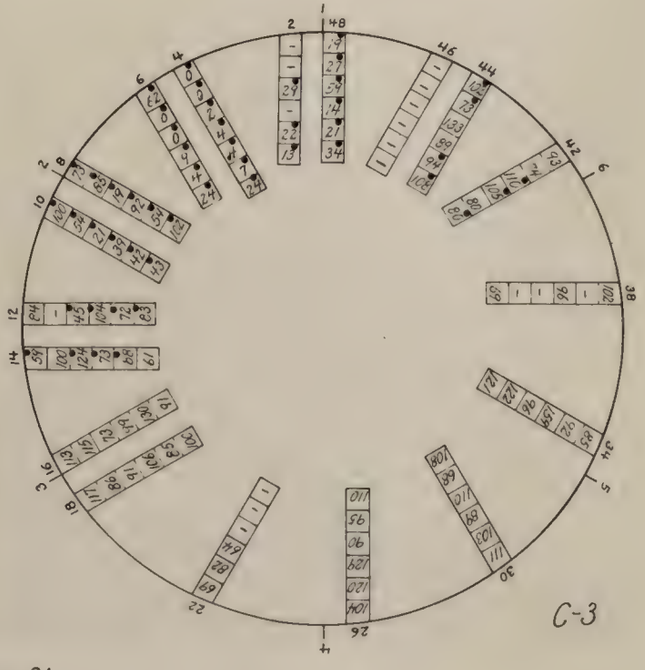
Figure-20











CROSS SECTIONS SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING TOUGHNESS VALUES -PERCENTAGE BASIS-

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

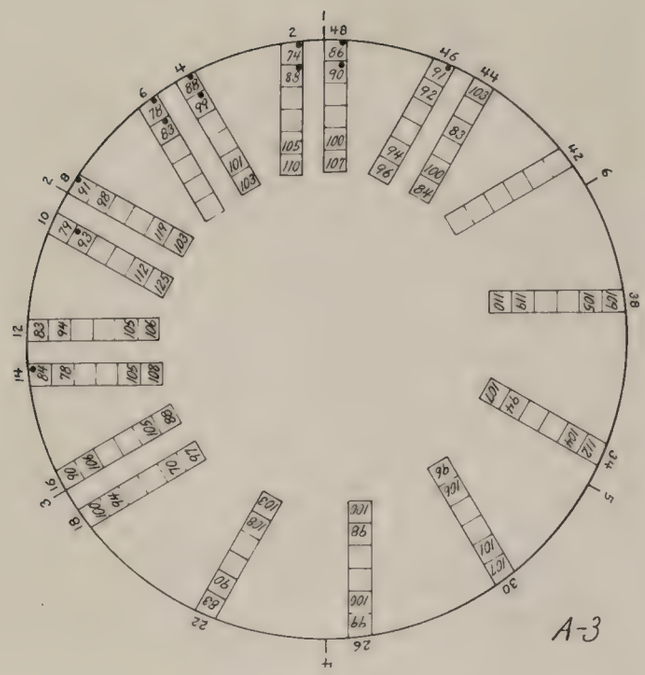
TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	B-3, C-1, C-2, C-3, D-1.	TRAMETES PINI

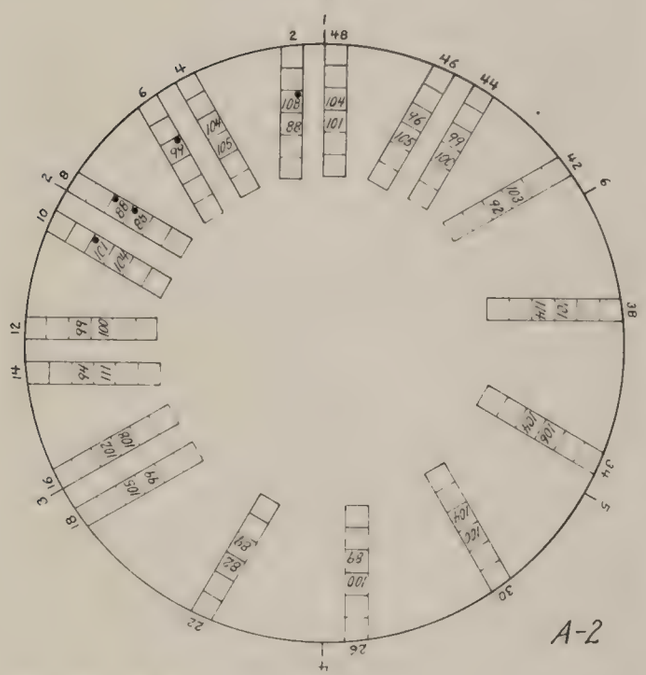
LEGEND
● = INFECTED

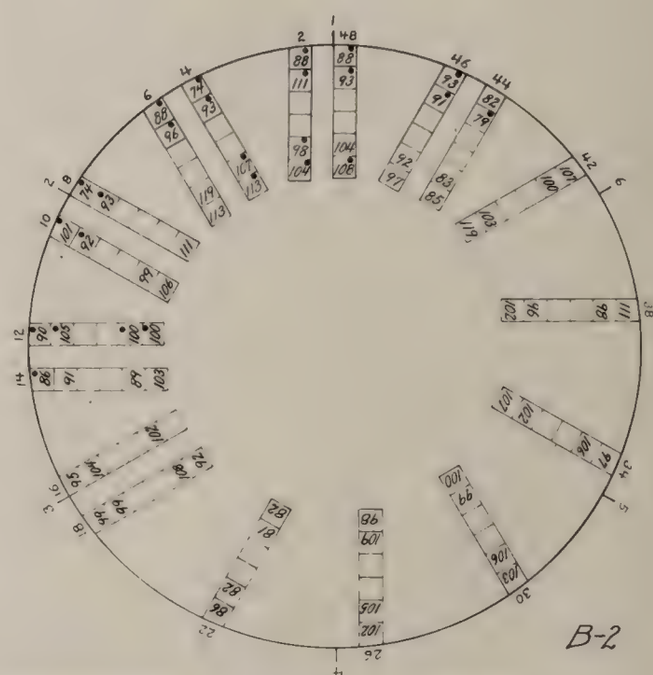
SHIPMENT 9874
TREE 3
PROJ. 243-J1

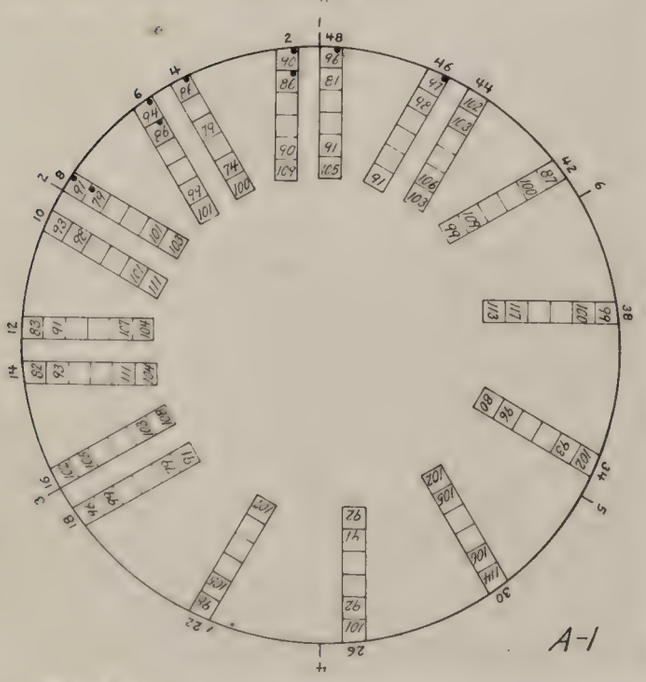
M1142F

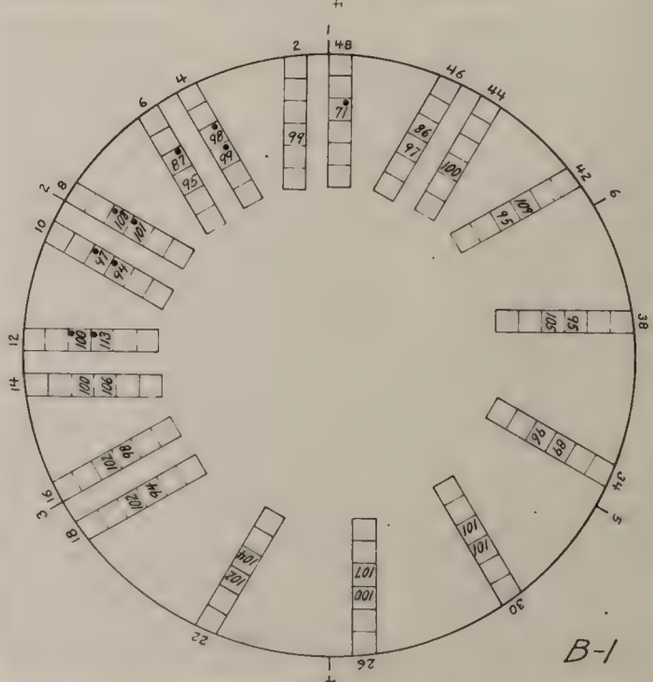
Figure-21











CROSS SECTIONS SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES -PERCENTAGE BASIS-

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

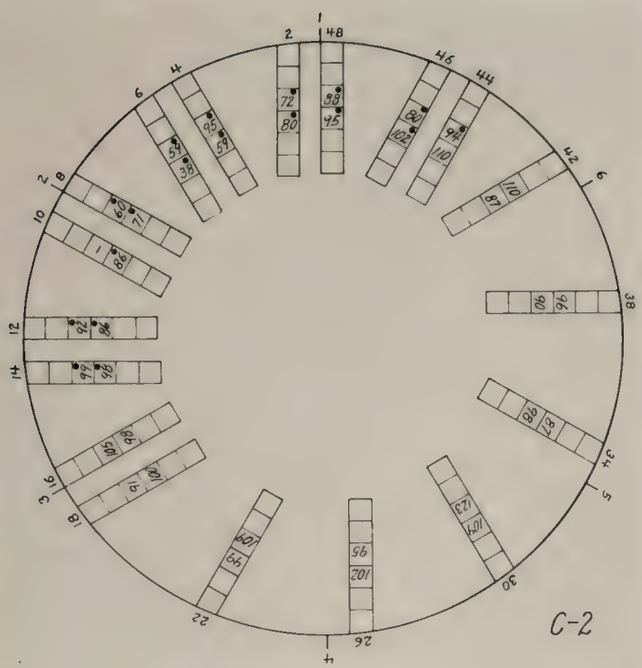
TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	A-1, A-2, A-3, B-1, B-2.	TRAMETES PINI

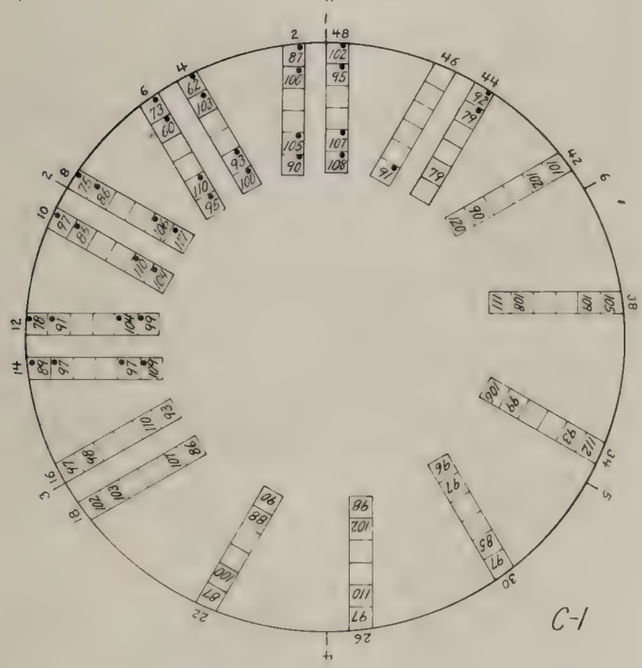
LEGEND
• = INFECTED

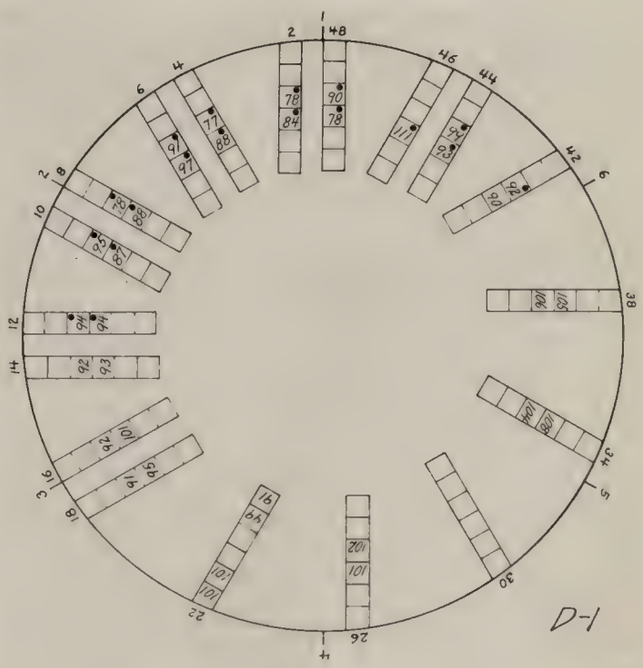
SHIPMENT 987 R&I
TREE 3
PROJ. 243-J1

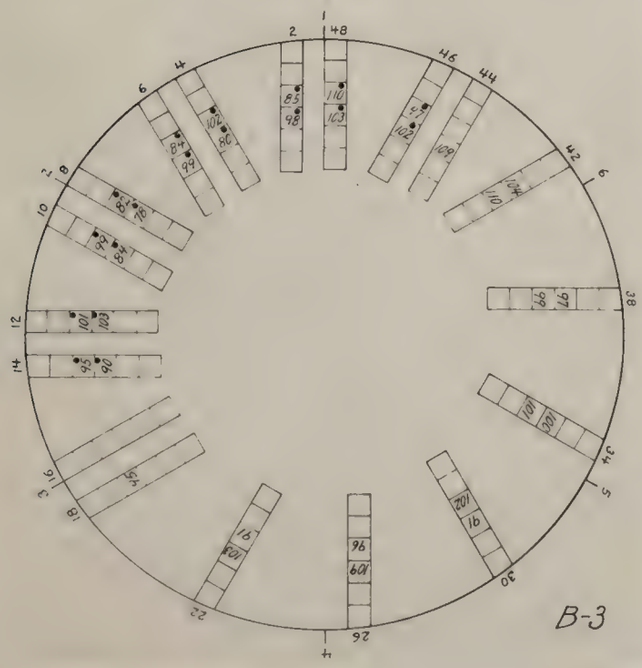
M 1143 F

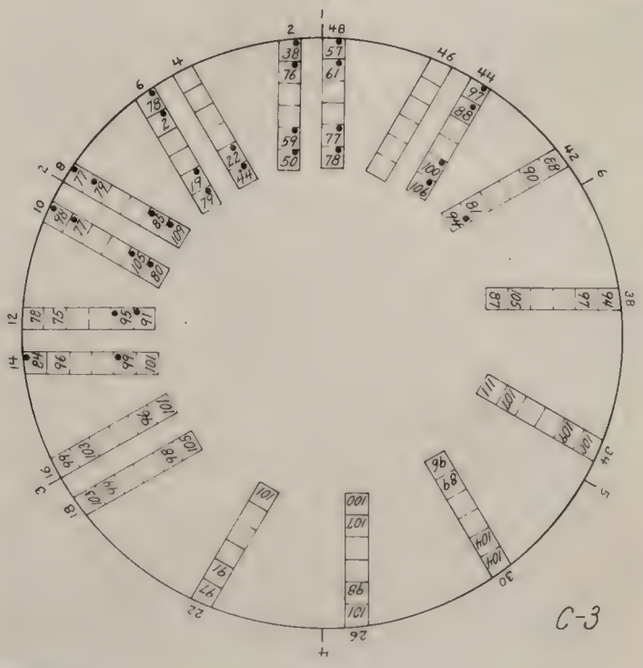
Figure-22











CROSS SECTIONS SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING COMPRESSION PARALLEL TO GRAIN VALUES -PERCENTAGE BASIS-

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

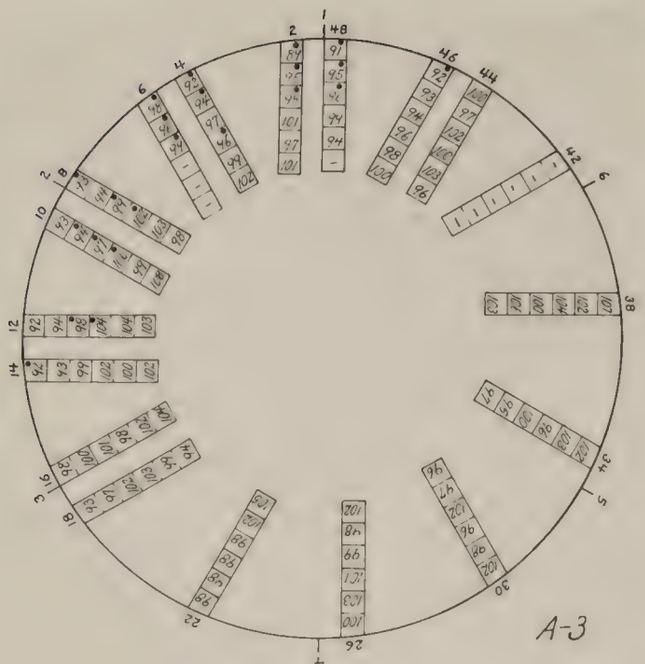
TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	B-3, C-1, C-2, C-3, D-1.	TRAMETES PINI

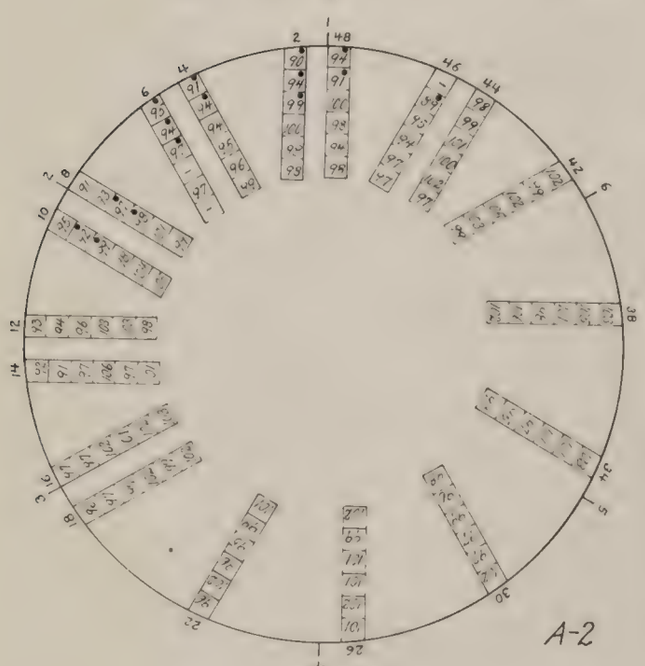
LEGEND
● = INFECTED

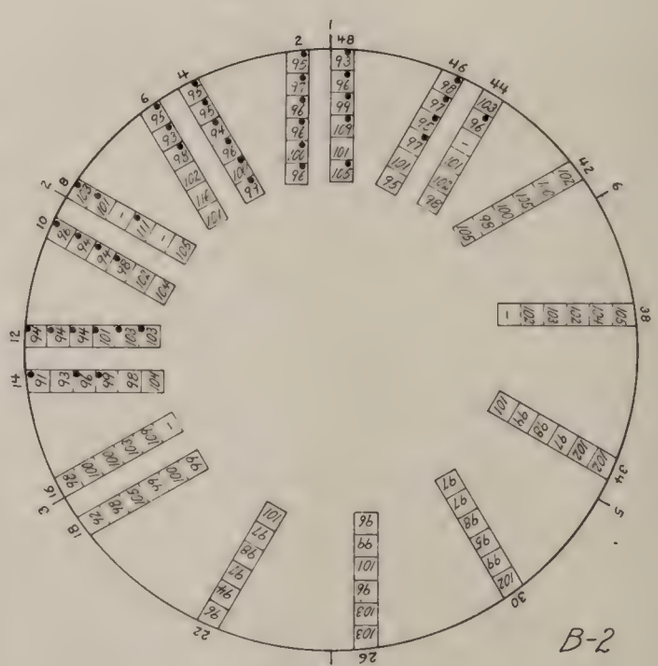
SHIPMENT 987 R8h
TREE 3
PROJ. 243-J1

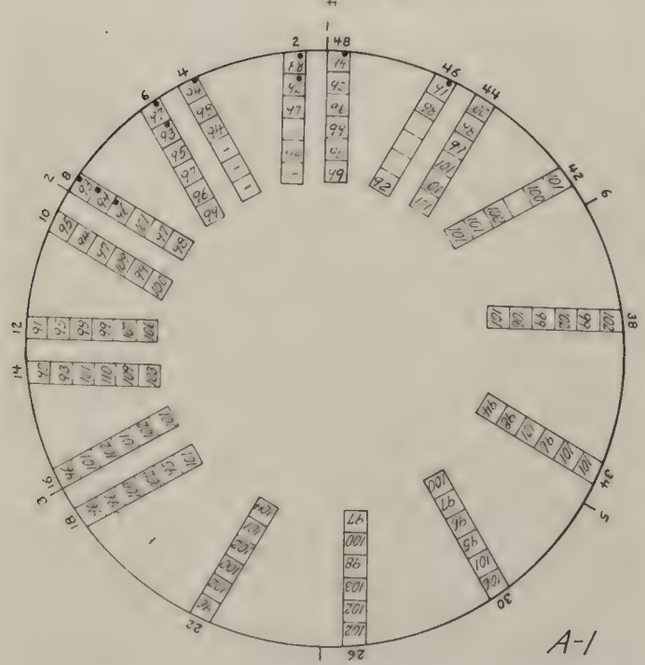
M1144F

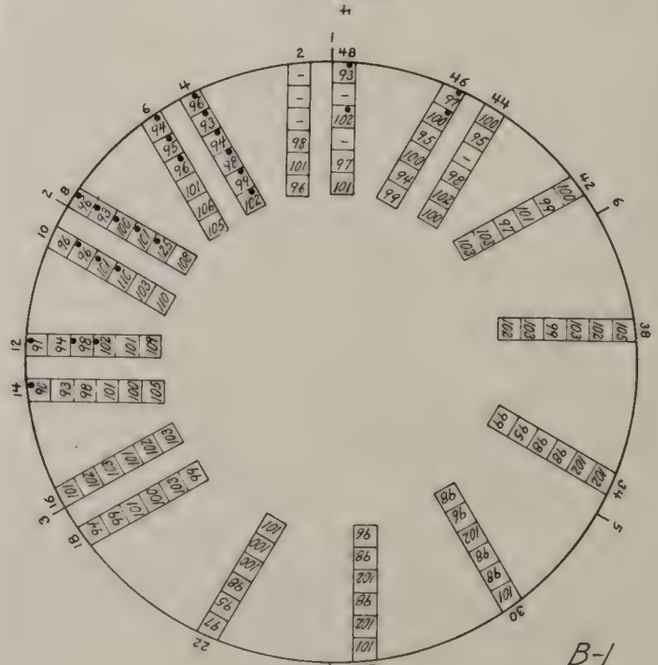
Figure-23











CROSS SECTIONS SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING SPECIFIC GRAVITY VALUES -PERCENTAGE BASIS-

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

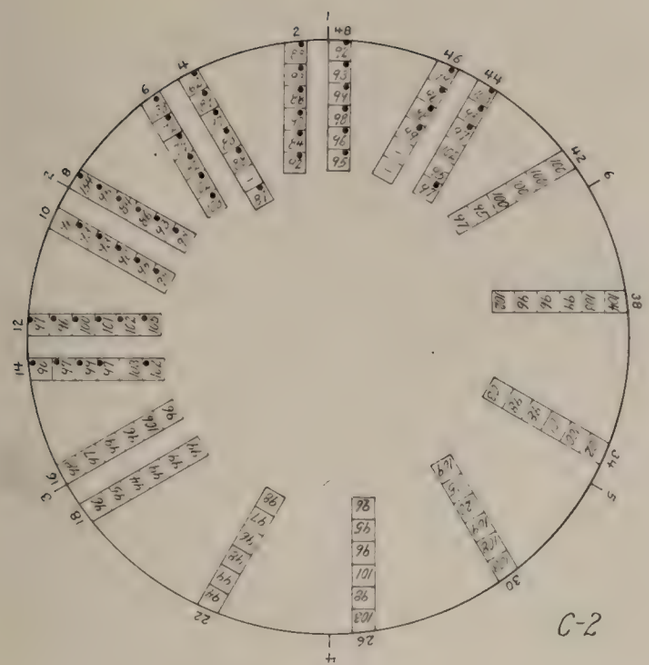
TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	A-1, A-2, A-3, B-1, B-2	TRAMETES PINI

LEGEND
• = INFECTED

SHIPMENT 987 A & L
TREE 3
PROJ. 243-J1

M 1145 F

Figure-24



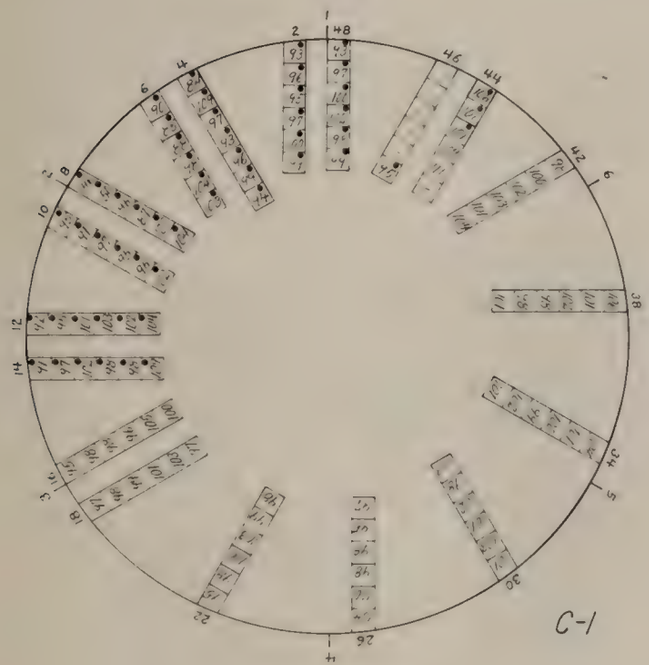
CROSS SECTIONS SHOWING DISTRIBUTION OF SPECIMENS WITH CORRESPONDING SPECIFIC GRAVITY VALUES -PERCENTAGE BASIS-

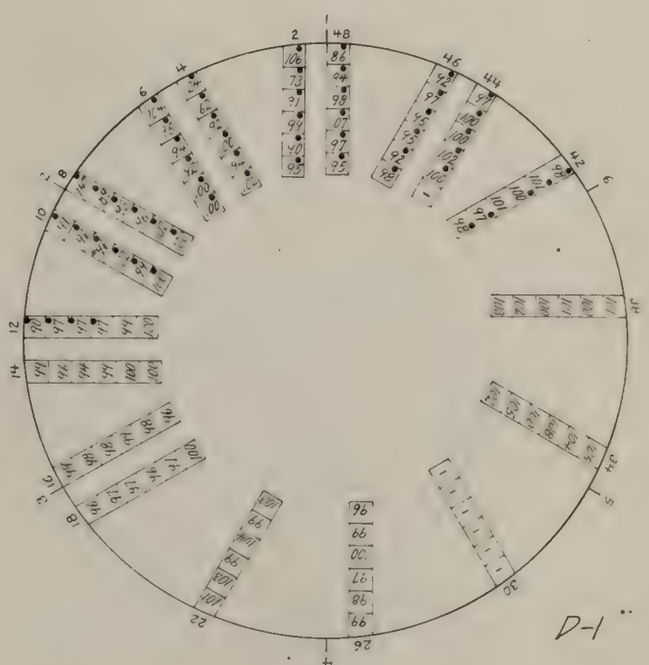
(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	B-3, C-1, C-2, C-3, D-1.	TRAMETES PINI

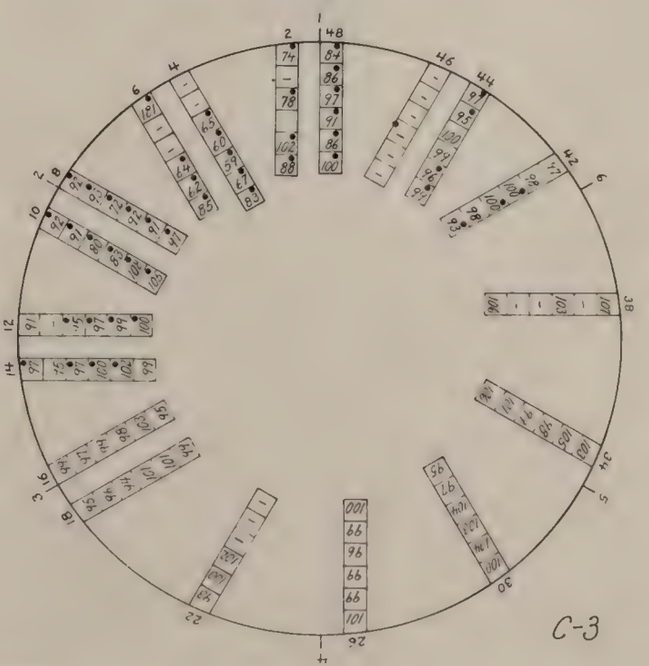
LEGEND
● = INFECTED

SHIPMENT 987 9 8 1
TREE 3
PROJ. 243-J1









M1146F

Figure-25

Figures 26 and 31

Figures 26 to 31 inclusive present graphically, by means of polar coordinate diagrams, the data from tree 3 infected with Fomes pini. Each radius represents the position of a certain board and the plotted point or points on this line the average of infected and average of uninfected specimens from that board. All plotted values are in terms of percentage of corresponding control values. The plotted points have been connected with smooth curves for purposes of more ready comparison.

POLAR COORDINATE DIAGRAMS SHOWING AVERAGE TOUGHNESS VALUES — PERCENTAGE BASIS —

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	A-1, A-2, A-3, B-1, B-2	TRAMETES PINI

Each plotted point represents the average value for infected or uninfected specimens from a single board within a sub-bolt length. The numbers on the radii correspond to the board numbers in figures 20-25

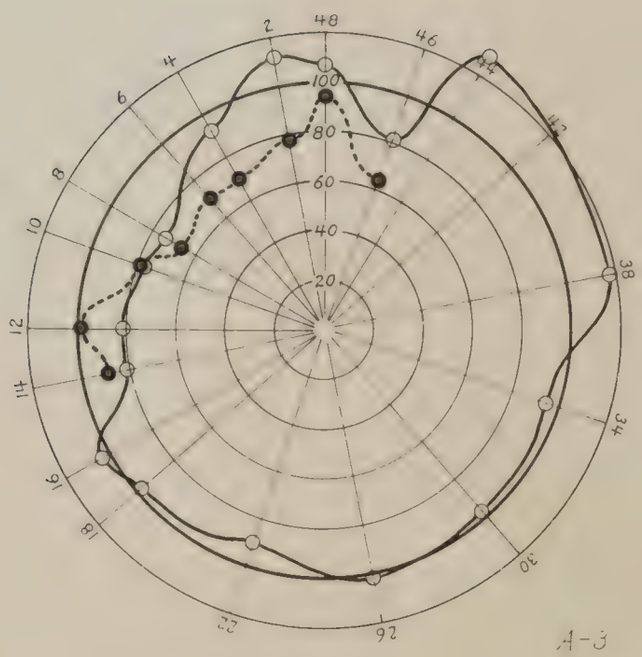
Legend:

●- - - - - infected

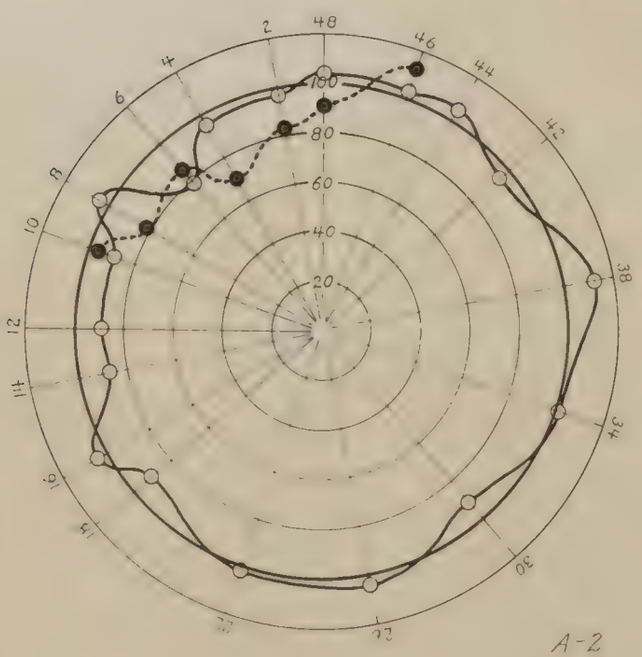
○——— uninfected

R.H.C.
R.B.I.

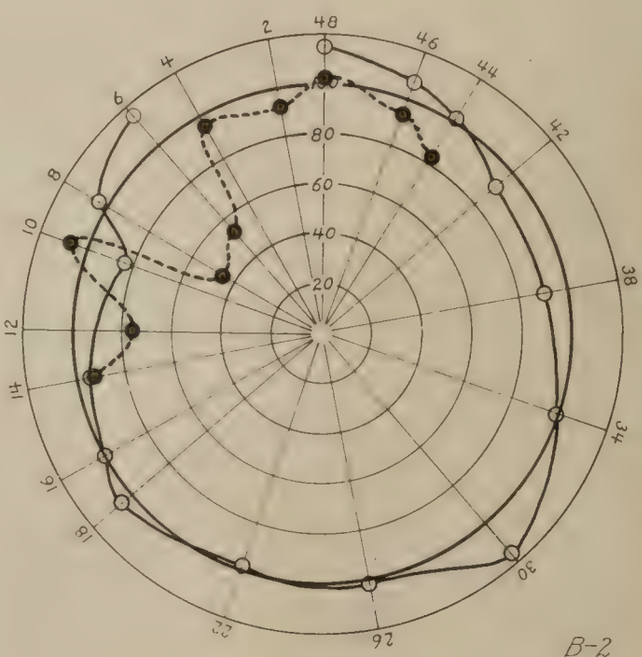
PROJECT 243-J1; SHIPMENT 987
TREE 3



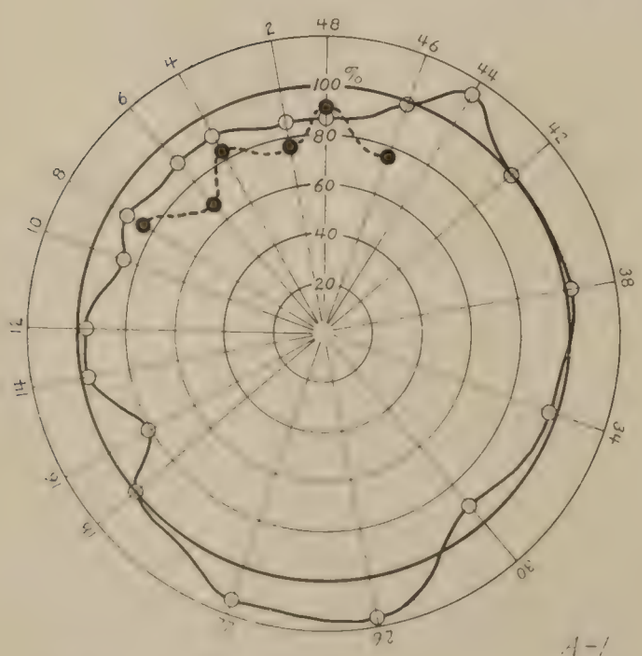
A-3



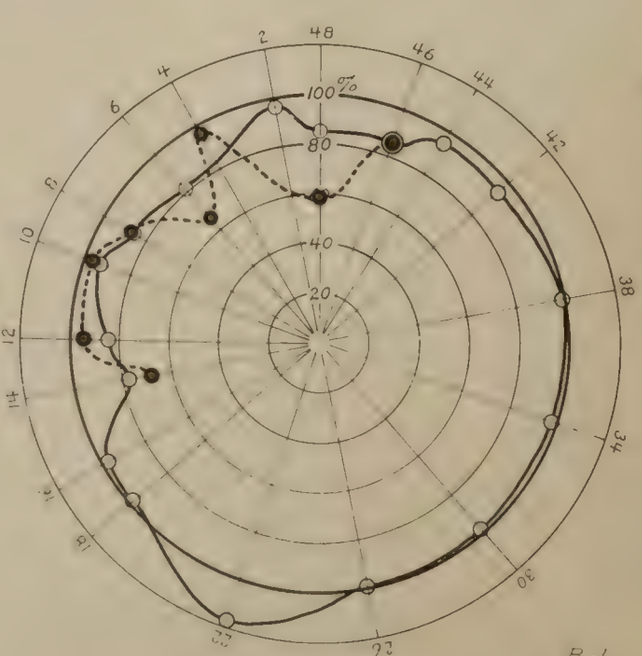
A-2



B-2



A-1



B-1

Figure-26

POLAR COORDINATE DIAGRAMS SHOWING AVERAGE TOUGHNESS VALUES — PERCENTAGE BASIS —

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	B-3, C-1, C-2, C-3, D-1	TRAMETES PINI

Each plotted point represents the average value for infected or uninfected specimens from a single board within a sub-bolt length. The numbers on the radii correspond to the board numbers in figures 20-25

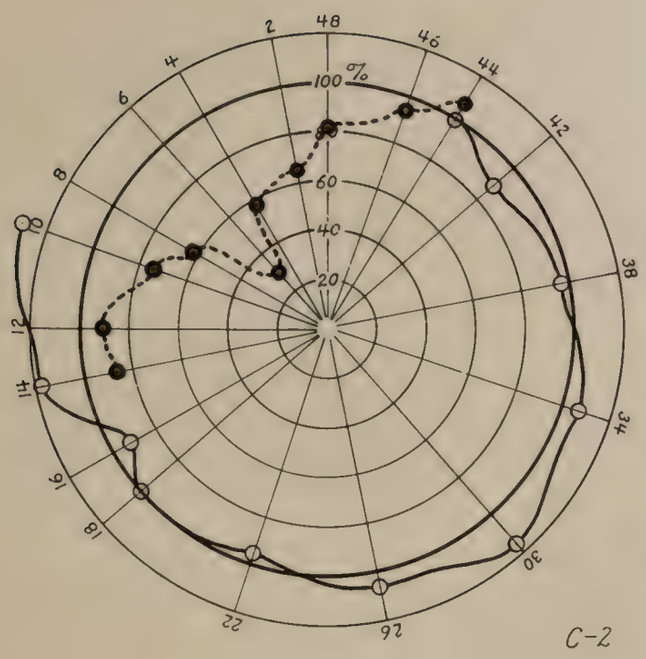
Legend:

●- - - - - infected

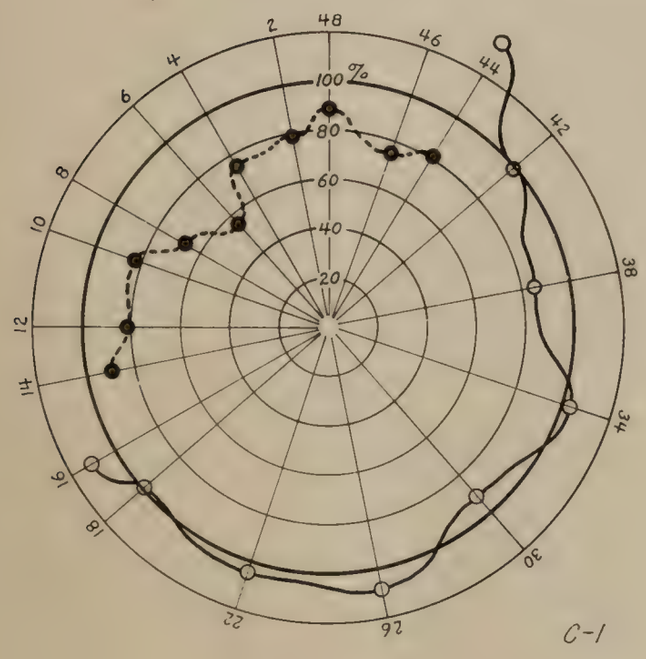
○——— uninfected

R.H.C.
R.B.L.

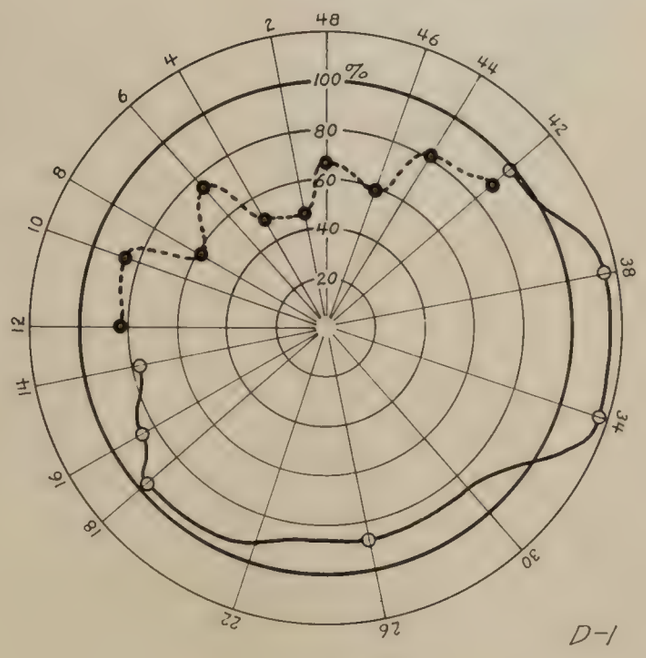
PROJECT 243-J1; SHIPMENT 987
TRI F 3



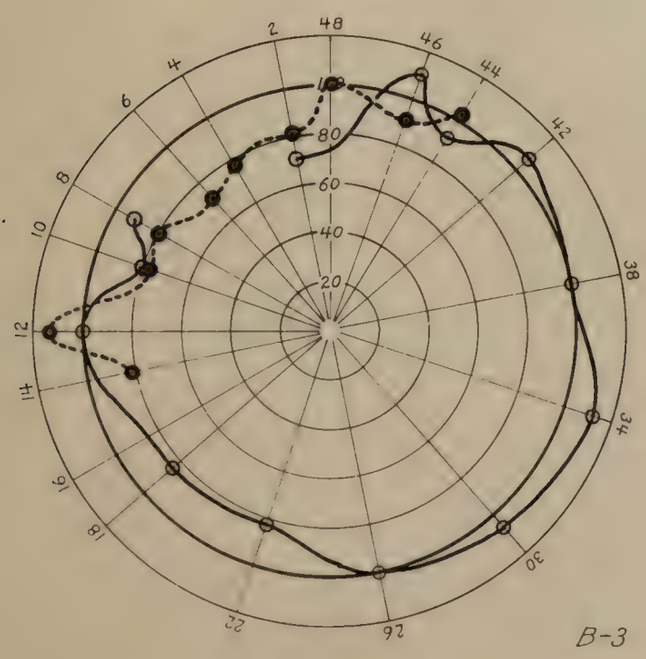
C-2



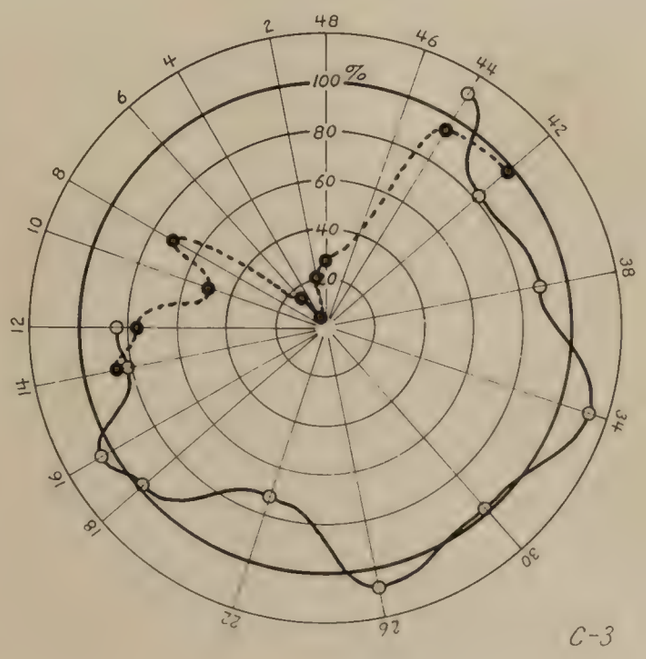
C-1



D-1



B-3



C-3

Figure-27

POLAR COORDINATE DIAGRAMS SHOWING AVERAGE COMPRESSION PARALLEL TO GRAIN VALUES — PERCENTAGE BASIS —

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	A-1, A-2, A-3, B-1, B-2	TRAMETES PINI

Each plotted point represents the average value for infected or uninfected specimens from a single board within a sub-bolt length. The numbers on the radii correspond to the board numbers in figures 20-25

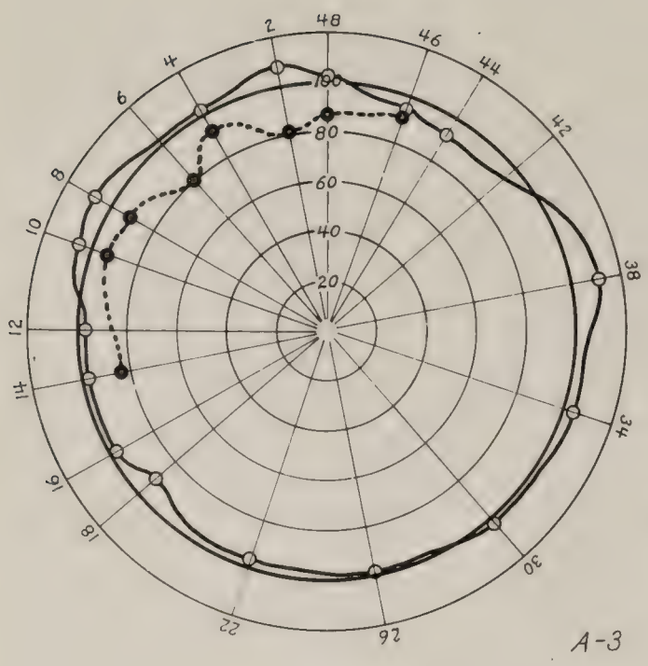
Legend:

●- - - - - infected

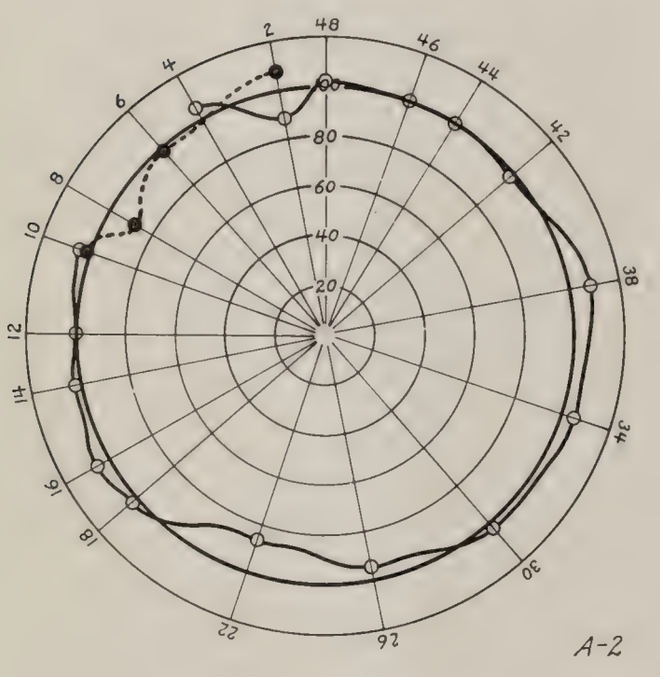
○——— uninfected

R.H.C.
A.B.J.

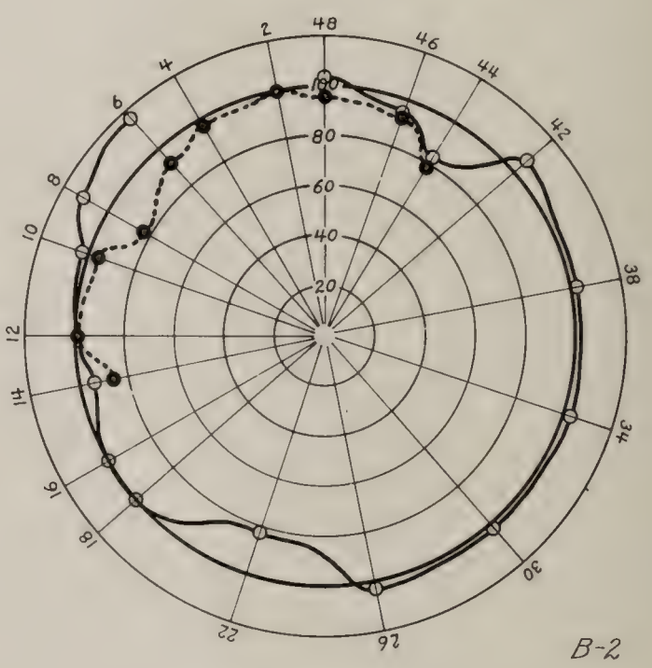
PROJECT 243-J1; SHIPMENT 987
TREE 3



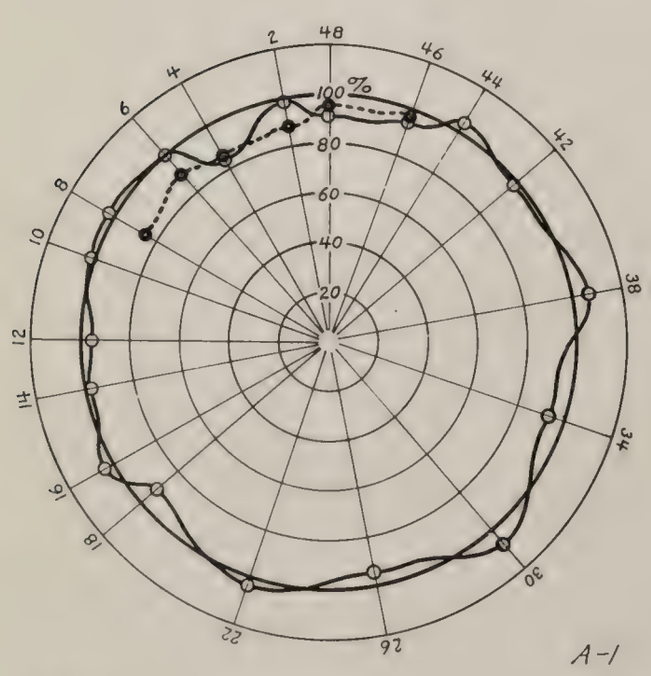
A-3



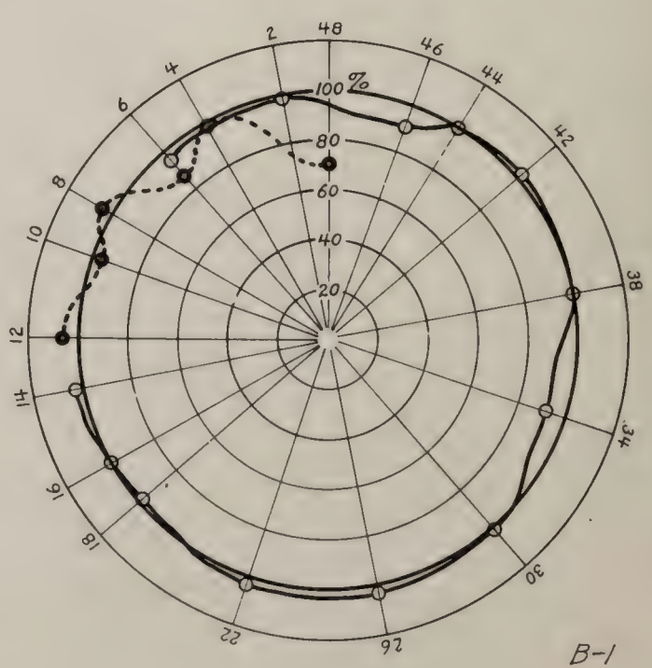
A-2



B-2



A-1



B-1

M 1115 F

Figure-28

POLAR COORDINATE DIAGRAMS SHOWING AVERAGE COMPRESSION PARALLEL TO GRAIN VALUES — PERCENTAGE BASIS —

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	B-3, C-1, C-2, C-3, D-1	TRAMETES PINI

Each plotted point represents the average value for infected or uninfected specimens from a single board within a sub-bolt length. The numbers on the radii correspond to the board numbers in figures 20-25

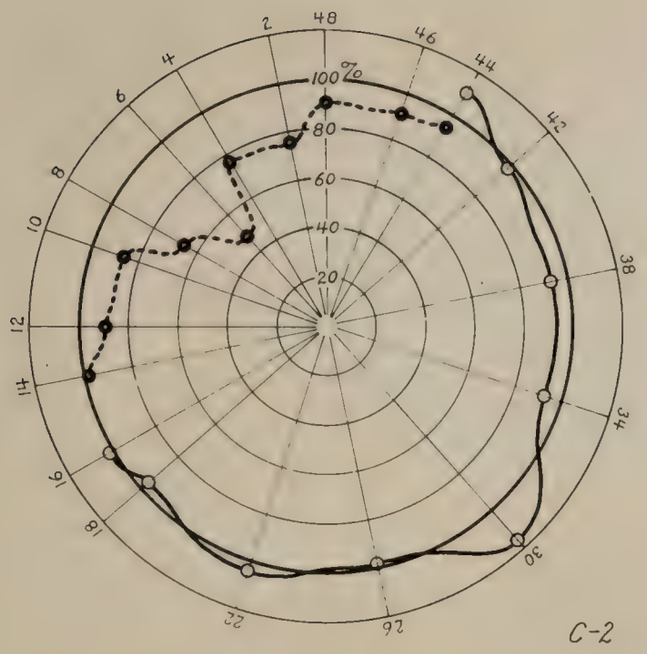
Legend:

●- - - - - infected

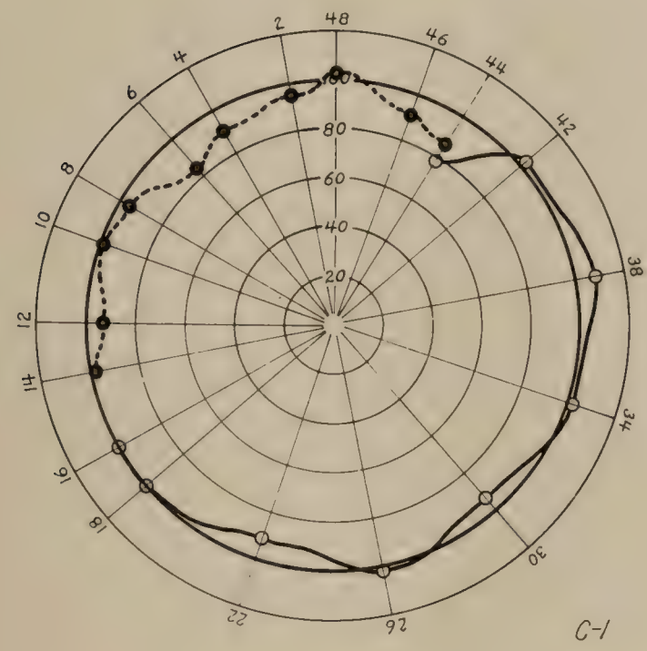
○——— uninfected

R.H.C.
R.F.L.

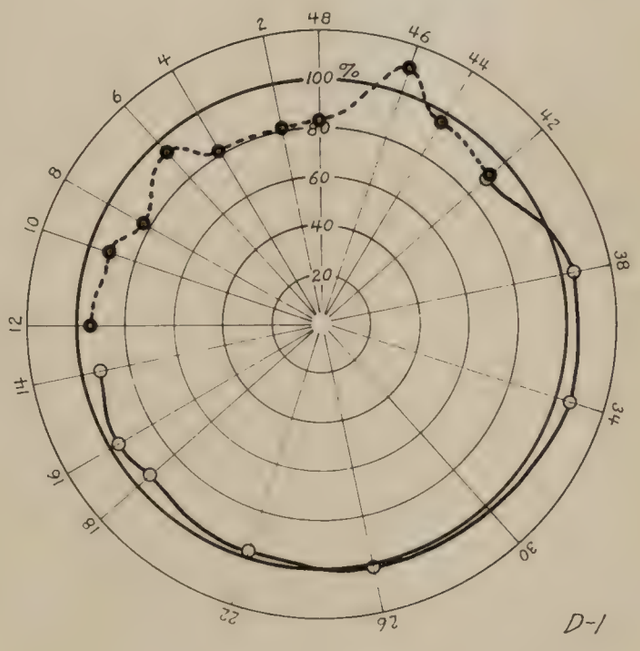
PROJECT 243-J1; SHIPMENT 987
TRTE 3



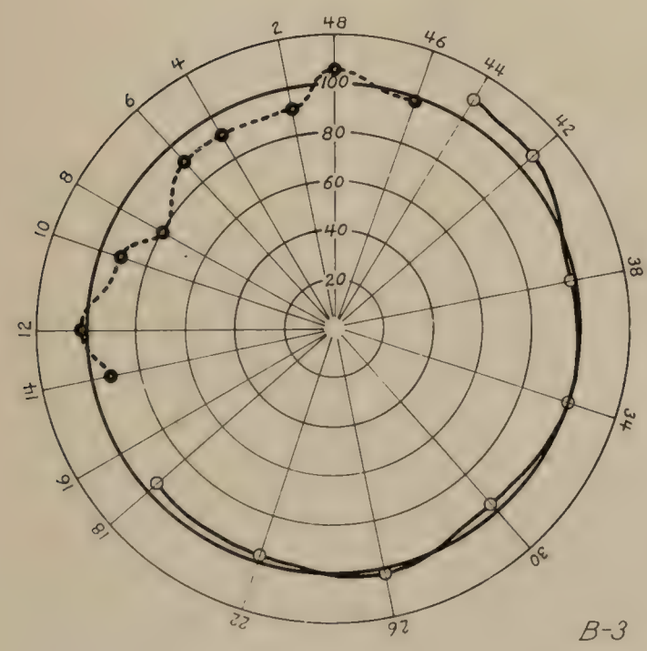
C-2



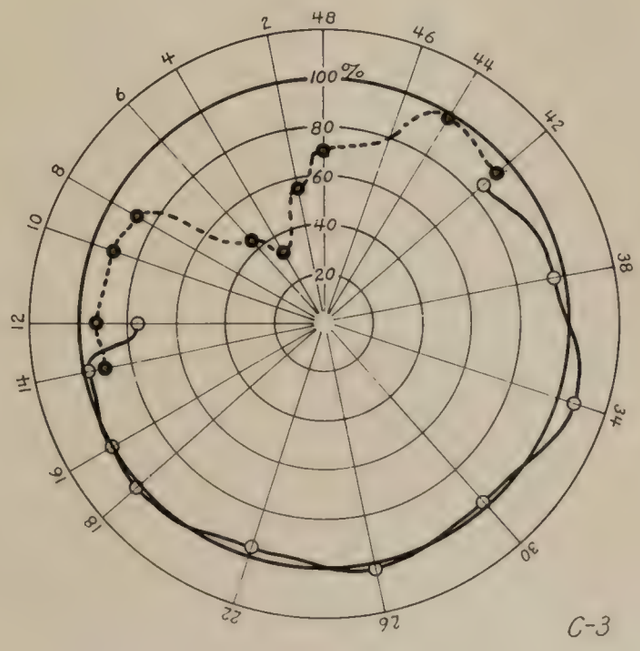
C-1



D-1



B-3



C-3

M 1116 F

Figure -29

POLAR COORDINATE DIAGRAMS SHOWING AVERAGE SPECIFIC GRAVITY VALUES — PERCENTAGE BASIS —

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	A-1, A-2, A-3, B-1, B-2	TRAMETES PINI

Each plotted point represents the average value for infected or uninfected specimens from a single board within a sub-bolt length. The numbers on the radii correspond to the board numbers in figures 20-25

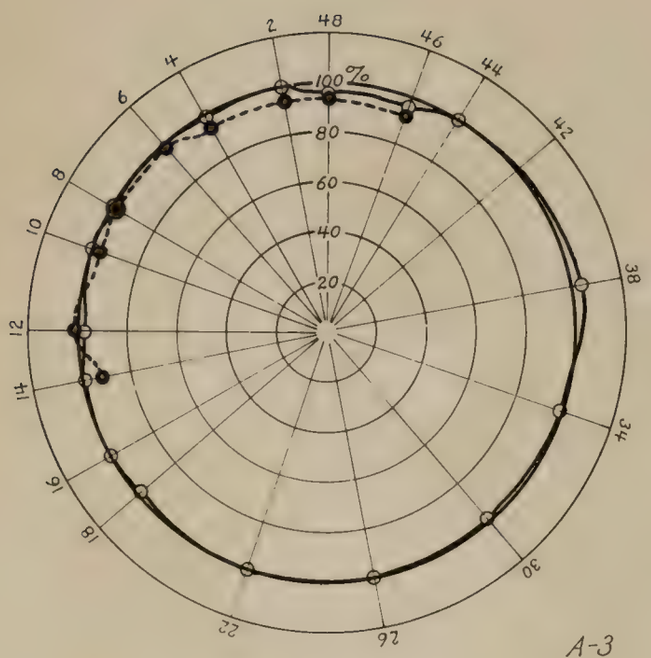
Legend:

●- - - - - infected

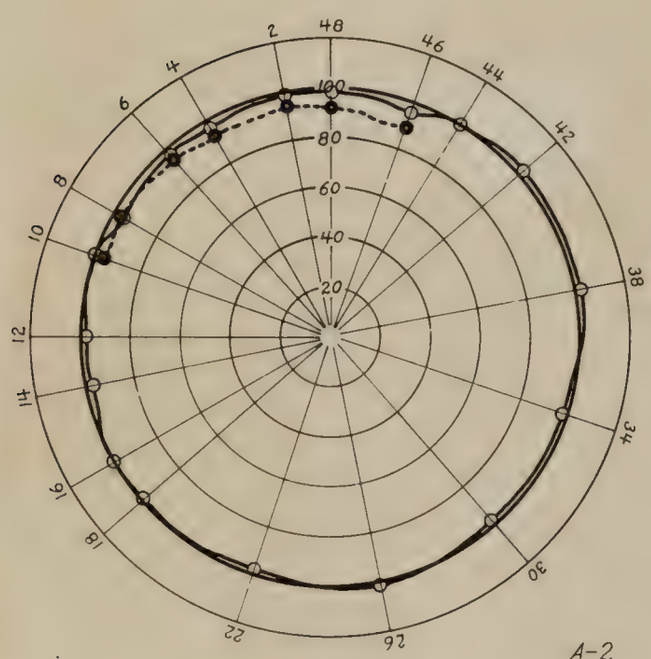
○——— uninfected

R.H.C.
R.F.L.

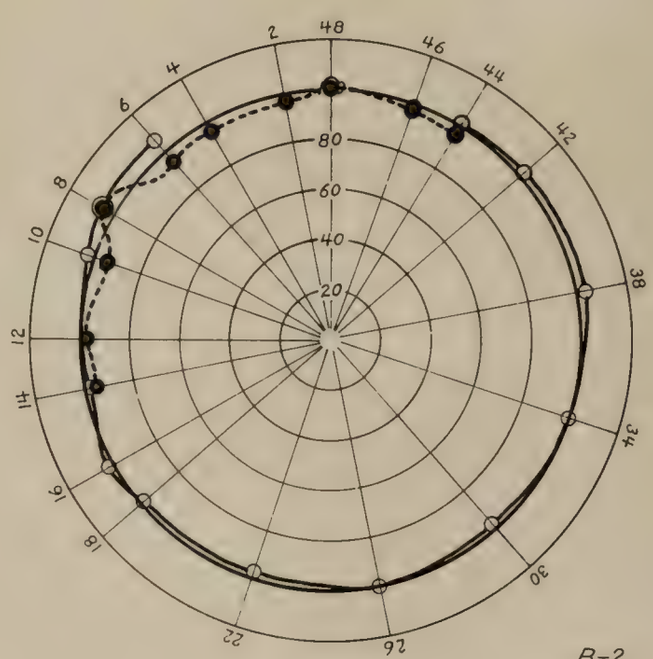
PROJECT 243-J1; SHIPMENT 987
TREE 3



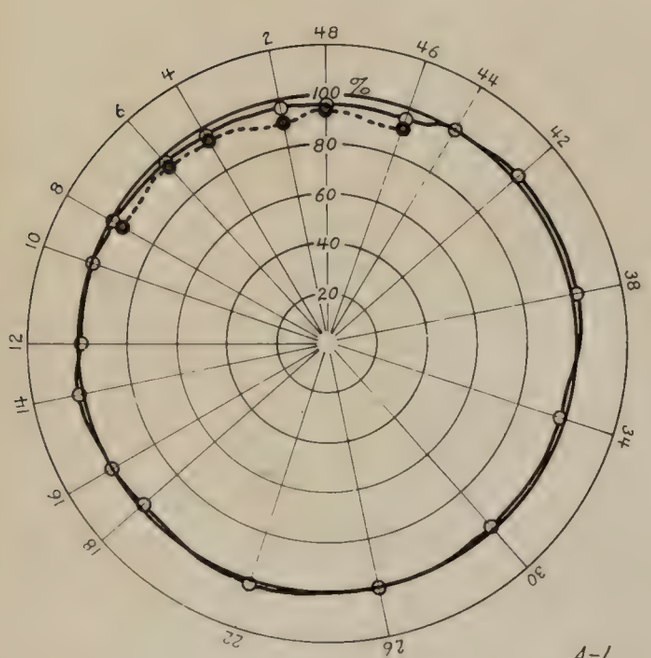
A-3



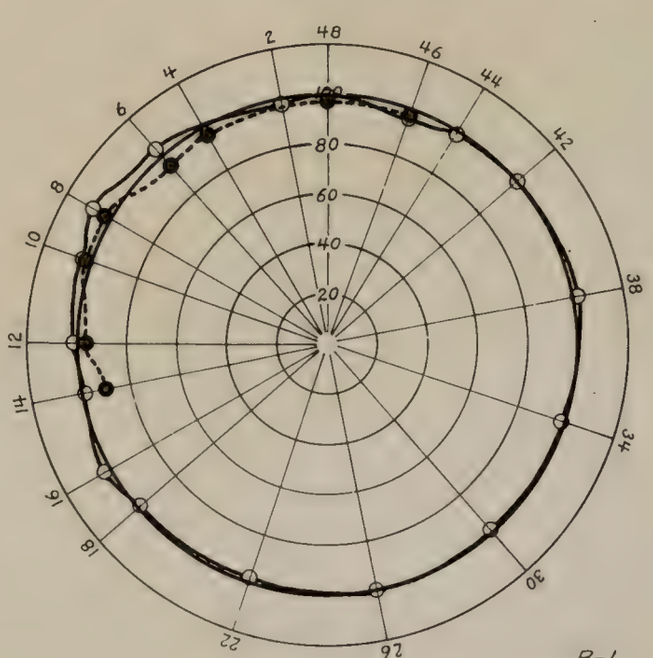
A-2



B-2



A-1



B-1

Figure-30

POLAR COORDINATE DIAGRAMS SHOWING AVERAGE SPECIFIC GRAVITY VALUES — PERCENTAGE BASIS —

(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

TREE SPECIES	BOLTS	FUNGUS SPECIES
SITKA SPRUCE	B-3, C-1, C-2, C-3, D-1	TRAMETES PINI

Each plotted point represents the average value for infected or uninfected specimens from a single board within a sub-bolt length. The numbers on the radii correspond to the board numbers in figures 20-25

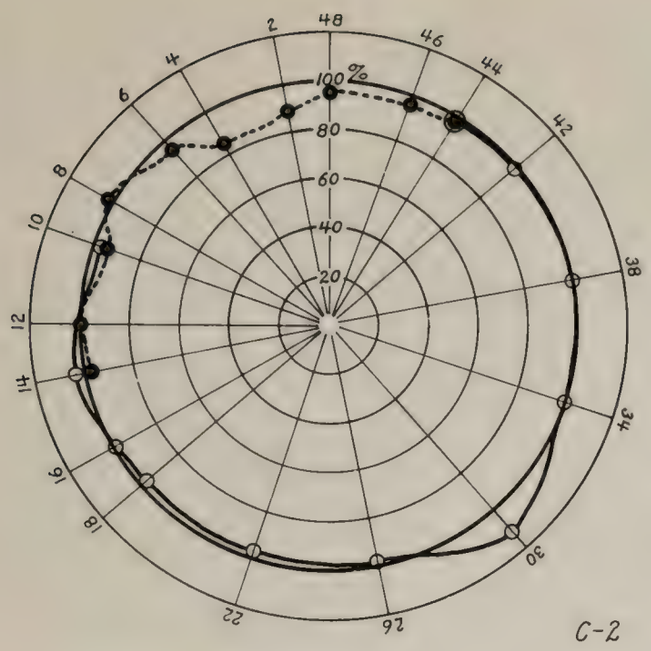
Legend:

●- - - - - infected

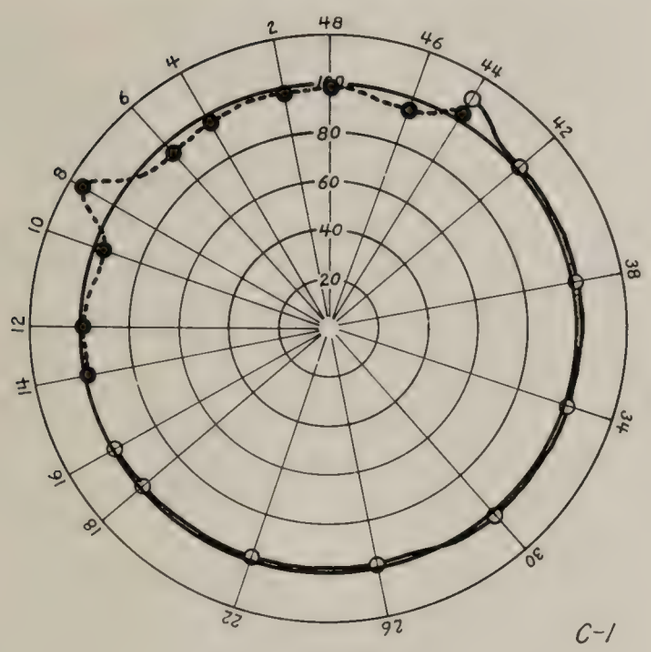
○——— uninfected

R.H.C.
R.B.I.

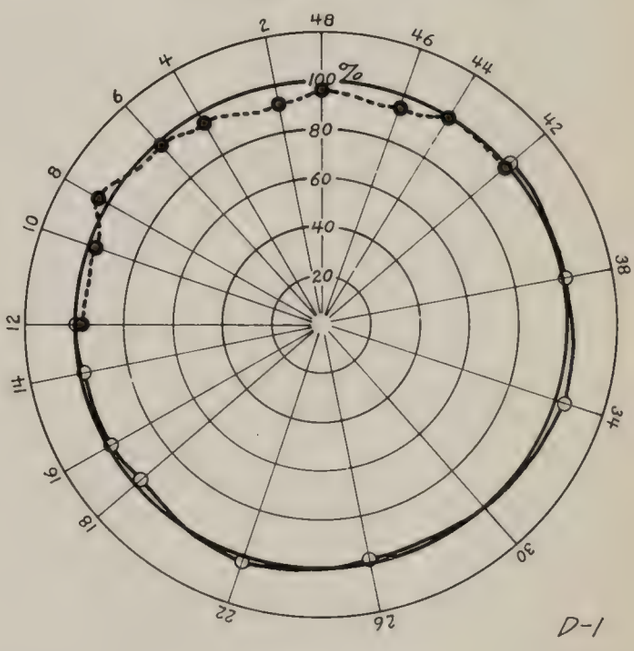
PROJECT 243-J1; SHIPMENT 987
TREE 3



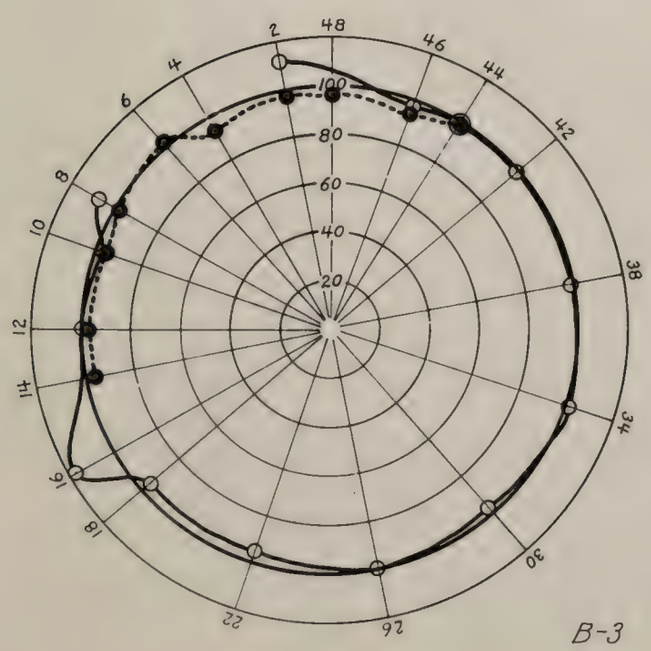
C-2



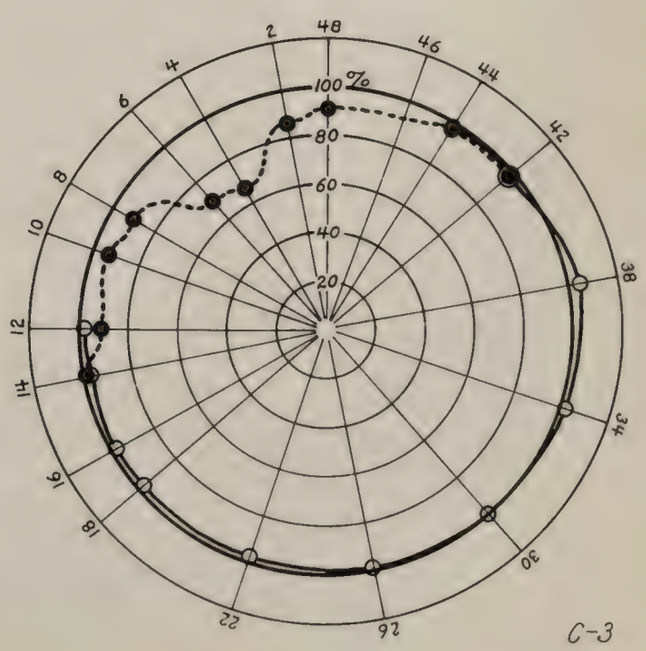
C-1



D-1



B-3



C-3

M11187

Figure-31

Figs. 26 to 31 show the effect of Trametes pini on the toughness, compression parallel to grain and specific gravity values from the early stages of infection to advanced decay. Diagrams for sub-bolts A-1, A-2, and A-3, included in Figs. 26, 28, and 30 present data based on material which showed the least amount of decay. These diagrams indicate that in the early stages of infection the loss in toughness is from 10 to 30 per cent, the loss in compression parallel 10 to 20 per cent, while the reduction in specific gravity rarely exceeds 10 per cent. All of these reductions, however, are doubtless larger than would be accounted for by decay alone, in view of the fact that the values for uninfected material within the same region were considerably lower than the control values. Apparently the normal strength of material on the infected side of the tree was somewhat lower than on the opposite side which yielded the control specimens. The strength of material containing the maximum stage of infection in the material tested is represented by board 4, bolt C (see Figs. 27, 29, and 31). The average toughness for this board was reduced to 5 per cent, while the average compression parallel to grain value was reduced to 33 per cent and the specific gravity to 67 per cent of their original values.

While there was no consistent change in the specific gravity of tree 3 from the center out (for the parts used), certain regions were apparently of superior quality. For example, board 30 of bolt C-2 (Fig. 31) had a specific gravity of 110 per cent. This somewhat higher quality was reflected in the toughness and compression parallel to grain values as shown by corresponding cross sections.

The longitudinal sections, Fig. 32, through the region of greatest infection show graphically the relation of toughness, compression parallel to grain, and specific gravity at different weights in tree. These values are averages only for the plane represented, and not for complete cross sections of the tree. It will be noted that the compression parallel to grain and toughness values for infected specimens represented in bolt C-3 (Fig. 32) show a decided reduction, while the specific gravity value indicates little reduction in weight. This is, however, rather misleading, since, as a matter of fact, most of the specific gravity values included in the average of the infected specimens from board 6, representing bolt C-3, were low. The average approximates 100 per cent only because of the high weight of one specimen which had been thoroughly infiltrated with resin. If this one specimen is omitted the average specific gravity

Figure 32

The sketch A at the left represents a longitudinal section through the region of greatest infection in tree 3, designated 6-30, and represented in sketch B. The portion of tree tested and relative position of sub-bolts are indicated.

The three diagrams C, D, and E present graphically the toughness, maximum crushing strength in compression parallel to grain, and specific gravity (expressed on a percentage basis) of material adjacent to the 6-30 plane, and extending throughout the length of the log studied. These diagrams are constructed from the polar coordinate diagrams.

The solid lines represent uninfected and the dotted lines infected material. The solid lines at the left from A-1 to B-2 are due to the fact that boards from which these averages were obtained included both infected and uninfected material.

-B-

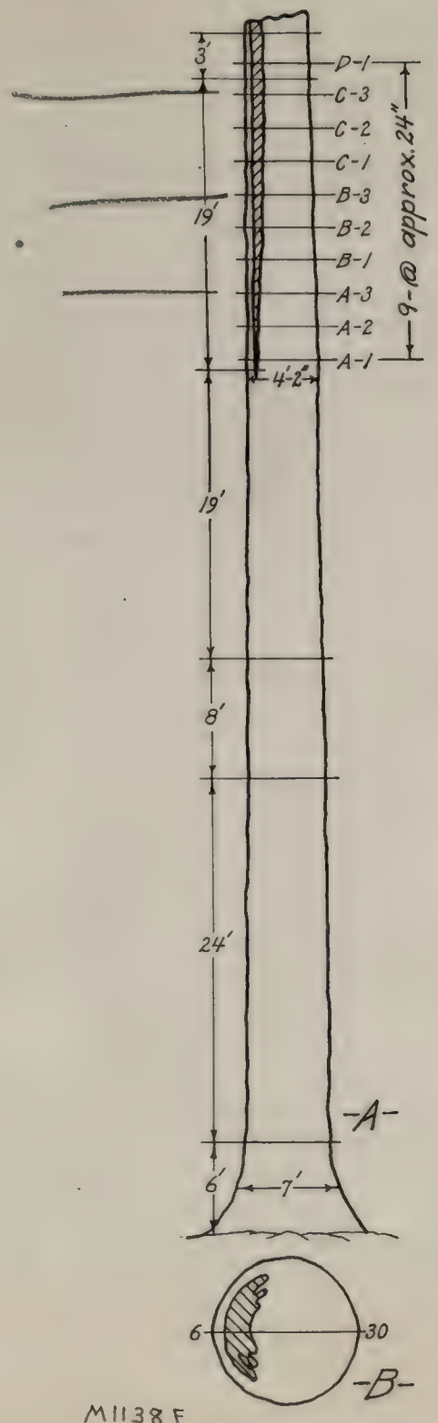
Figure-32

M1138 F

TREE 3; SHIPMENT 987; PROJ. 243-J1

Serial Path.-1

SKETCH SHOWING LOCATION OF INFECTED MATERIAL AND OF PART OF TREE TESTED



M1138 F

DIAGRAMS SHOWING VALUES OF CERTAIN PROPERTIES (PERCENTAGE BASIS) AT A PLANE PASSING THROUGH THE REGION OF MAXIMUM INFECTION

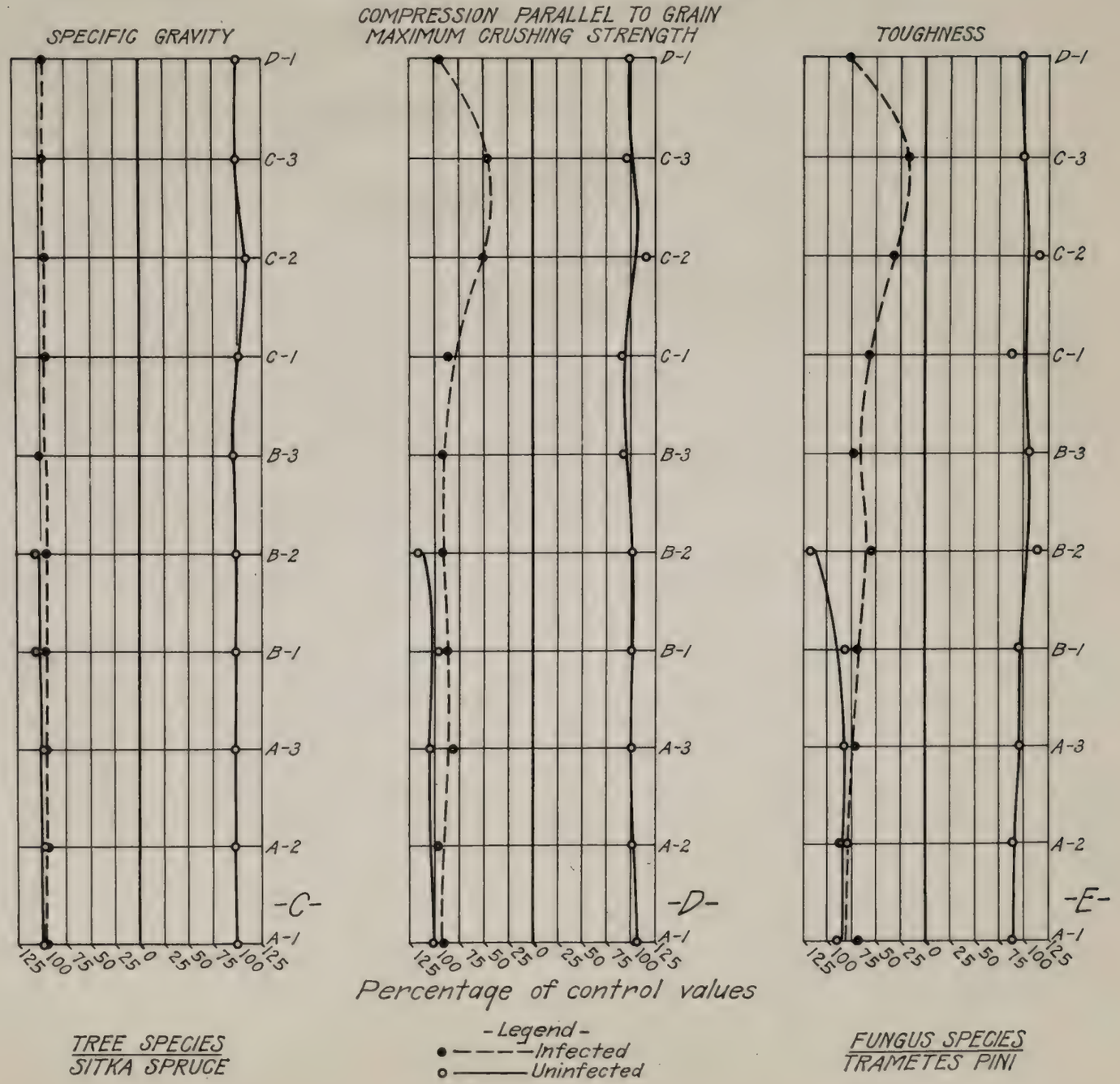


Figure-32

TREE 3; SHIPMENT 987; PROJ. 243-J1

is about 70 per cent (see Fig. 31, C-3, radius 6). High gravity values in material infected with Trametes pini are explained, in many cases at least, by the presence of exceptional amounts of resin[6]. The high average specific gravity for boards 4 and 5, bolt D-1, and boards 6 and 8, bolt C-2 (see Figs. 25 and 31), for example, are thus accounted for.

Comparison of Polyporus Schweinitzii and Trametes pini with Respect to Their Effect on Strength Properties of Sitka Spruce

The final effect of the action of both the fungi on the strength properties of Sitka spruce is the same. The wood loses all of its strength, its appearance is markedly changed, and its substance can be crushed or crumbled with the fingers.

As previously mentioned, the material for investigation in this study was selected in the forest. Tree 9 was very badly butt-rotted, and the central portion of the bole below bolt A was so far gone that no material suitable for testing was available. It was found also on sawing up the log that some of the material at the center of the butt of bolt A fell apart in cutting.

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[6] There is some evidence that attack by Trametes pini stimulates resin production.

However, none of the material used in the tests was of the extremely friable character produced in the last stages of the action of the fungus. In the tests extreme reductions to 1 per cent, 40 per cent, and 80 per cent of the original values for toughness, compression parallel to grain, and specific gravity, respectively, were found. The average reduction in specific gravity for the most severely attacked material studied was about 10 per cent; and it was accompanied by approximately 30 per cent reduction in compression values and about 95 per cent reduction in toughness.

Some of the material tested from tree 5 (infected with Trametes pini) was in a very advanced condition of decay. In fact, a few of the specimens broke in the operator's hands before the toughness test could be made. The toughness value of such specimens was recorded as zero. One such specimen proved to have a compression parallel to grain value of 2 per cent. The average reduction in specific gravity for the most severely attacked material tested was about 30 per cent, as contrasted with about 10 per cent for Polyporus Schweinitzii. This was accompanied by a loss in toughness of about 95 per cent, the same for both fungi. In contrast to the 30 per cent reduction in compression as found for Polyporus Schweinitzii, however, the reduction was nearly 70 per cent for Trametes pini.

Relation of Appearance to Strength

The action of Polyporus Schweinitzii may be described as a uniformly progressive action in which all of the infected wood is more or less uniformly involved; while the action of Trametes pini is characterized by intense destruction in isolated or localized spots -- which become white pockets -- separated by wood in which the fungous action is at a minimum. The difference in the appearance of specimens infected with the two fungi is illustrated in Plates III and IV.

The progress of strength destruction by Polyporus Schweinitzii is not marked by any definite change in appearance of the wood. There are, of course, marked differences between slightly infected and badly decayed material, but classification into definite strength groups on the basis of visual appearance would be quite uncertain and subject to large error. In other words, there are no sharp breaks or signposts in the gradation of color or other visual characteristics from perfectly sound to badly decayed wood.

On the other hand, the beginning of the formation of white pockets marks a fairly definite stage in the progress of strength destruction by Trametes pini. Previous to the formation of the pockets the infected material can be expected to retain 90 per cent or more of its original toughness, with a fairly large proportion

TOUGHNESS TEST FAILURES

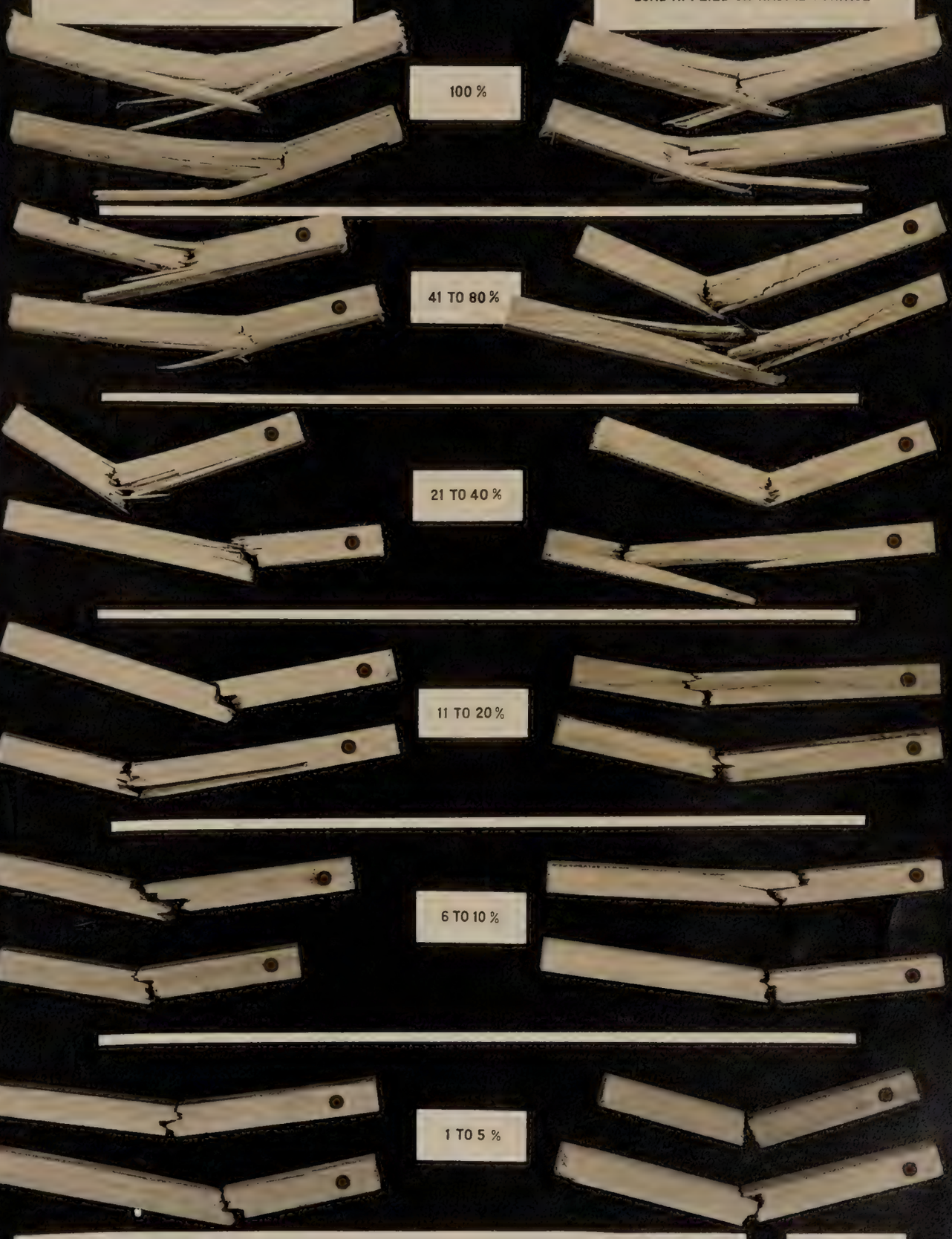
TREE SPECIES
SITKA SPRUCE

FUNGUS SPECIES
POLYPORUS SCHWEINITZII

REPRESENTATIVE SPECIMENS GROUPED ACCORDING TO THEIR TOUGHNESS VALUES
(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)

LOAD APPLIED ON TANGENTIAL SURFACE

LOAD APPLIED ON RADIAL SURFACE



● =INFECTED
ALL SPECIMENS ¾ X ¾ X 17 INCHES; SPAN 13½ INCHES, THIRD POINT LOADING

M921.F

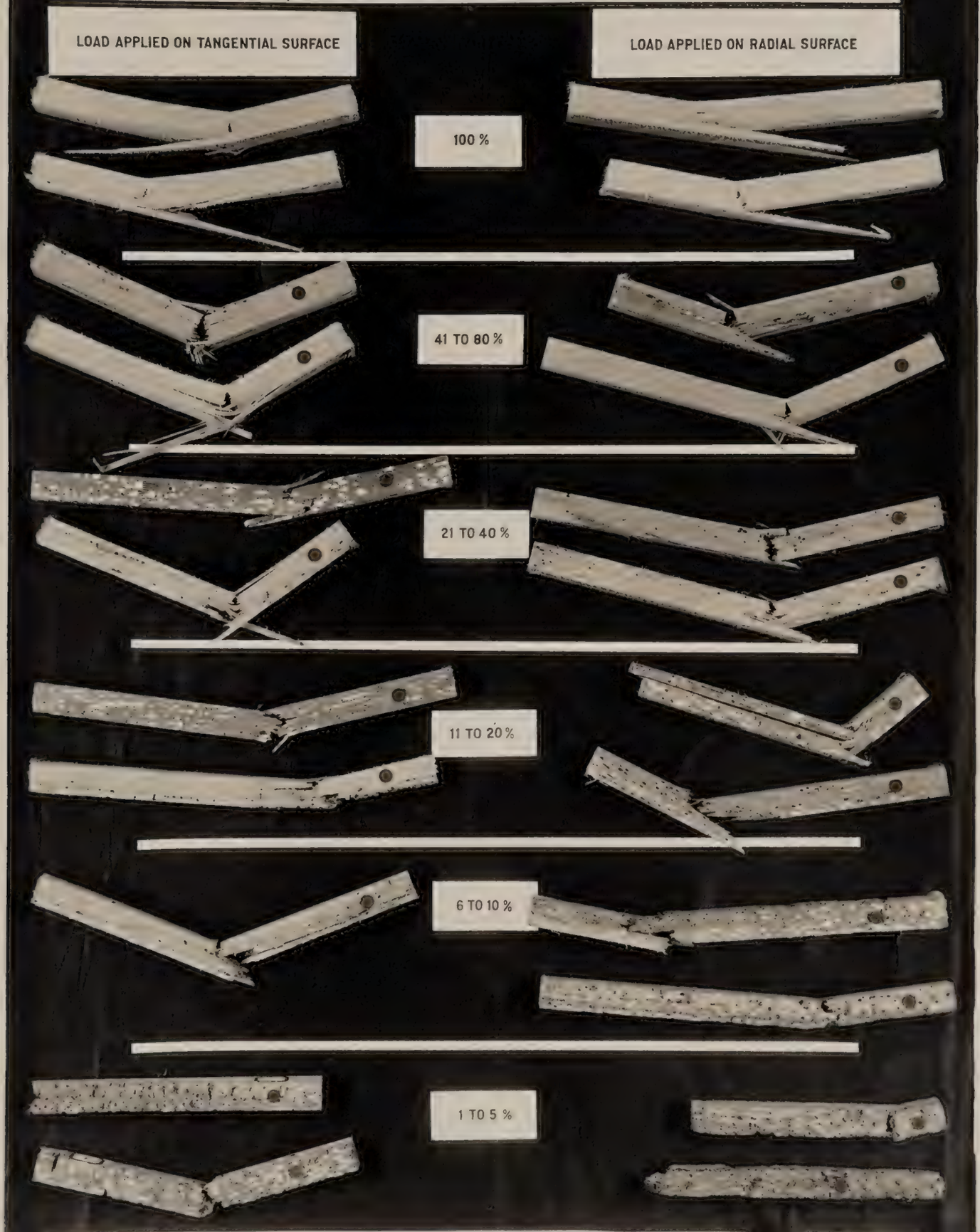
SHIPMENT L-987
PROJ. 243-J1
APRIL 3, 1925

TOUGHNESS TEST FAILURES

TREE SPECIES
SITKA SPRUCE

FUNGUS SPECIES
TRAMETES PINI

REPRESENTATIVE SPECIMENS GROUPED ACCORDING TO THEIR TOUGHNESS VALUES
(VALUES FOR UNINFECTED CONTROL SPECIMENS TAKEN AS 100 PER CENT)



● = INFECTED
ALL SPECIMENS ¾ X ¾ X 17 INCHES; SPAN 13½ INCHES, THIRD POINT LOADING

SHIPMENT L-987
PROJ. 243 - 11
APR. 3 '42

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retaining as much as 75 per cent. Such material can be expected to show a gravity loss of less than 10 per cent.

Characteristics of Material Near Infected Areas

While Trametes pini and Polyporus Schweinitzii both cause large reductions in strength in advanced stages of their development, Figs. 2 to 17 and 20 to 25 show that sound material close to an infected area is normal in strength properties. This indicates that a large part of the material from somewhat decayed trees is of as high quality as material from perfectly sound trees and can be used safely even where strength is of high importance, provided the limit of decay is established.

Conclusions

The results of this study of the effect of Polyporus Schweinitzii and Trametes pini on the specific gravity and strength properties of Sitka spruce lead to the following conclusions:

1. The action of both fungi with respect to specific gravity and strength properties is a progressive one, reduction of the properties beginning with the fungous attack and continuing until the wood is completely destroyed.

2. The final effect of the action of both fungi on the properties of Sitka spruce is the same.

The wood loses all its strength, and its substance can be crushed or crumbled with the fingers. (While it might appear to be obvious that the final effect of any fungus would be the loss of all strength, this is not known to be true.)

3. In the case of Polyporus Schweinitzii, the average values for the most decayed part of the tree studied show a reduction of 95 per cent in toughness strength accompanied by approximately 30 per cent and 10 per cent losses in compression parallel to grain and specific gravity, respectively.

4. In the case of Trametes pini the average values for the most decayed part of the tree studied show likewise a reduction of 95 per cent in toughness strength, but this is accompanied by approximately 70 per cent and 30 per cent losses in compression parallel to the grain and specific gravity, respectively.

5. From conclusions 3 and 4 it is evident that (1) under the action of the same fungus the several strength properties suffer different percentage reductions and (2) the relation between any two strength properties with respect to loss from fungous action varies with the fungus in question. Consequently a study of the effect of one fungus on the several properties and the effect of a second fungus on a single

property does not form a reliable basis for estimating the effect of the latter fungus on the other properties.

6. At the outer limit of Polyporus Schweinitzii infection, a reduction in the toughness of Sitka spruce of approximately 20 per cent was found, while a reduction of 20 per cent in toughness due to Fomes pini would not be expected before the formation of the white pockets.

7. The only visual indications of the presence of Polyporus Schweinitzii are pale yellowish longitudinal streaks in the wood in the very early stages and reddish brown discolorations in the later stages. The early growth stages of Fomes pini colors the wood to a light or dark brown, while the later stages are indicated by the presence of the white pockets typical for this fungus. The gradation of the variation in appearance from the early to later stages is, however, too indefinite for both types of fungi to afford a trustworthy basis of selection.

8. While both Polyporus Schweinitzii and Fomes pini cause marked reductions in strength in advanced stages, the material within a short distance of the infected area is normal in strength.

9. The large reductions in strength and, particularly, shock resistance caused by Polyporus Schweinitzii even in its early stages, and with no

appreciable reduction in specific gravity or change in appearance, illustrates the necessity of some mechanical test as a basis for selection where maximum strength is essential. Since shock resistance is the mechanical property which is affected first and to the largest extent by fungous attack, some test which will give a measure of this property is the most desirable. The toughness test previously mentioned in this report has been found to be the simplest test of this kind, and it is recommended as a most important aid in selection. It is important, however, that the test be accompanied by a careful visual examination of the material and supplemented by specific gravity determinations in the cases of those specimens which fall between the lower and upper acceptance values[7].

[7] See Toughness Tests of Airplane Woods (Sitka Spruce and White Ash) by R.F. Luxford.